10 MHz Dual-beam storage oscilloscope

PM3234

(9444 032 34...)

9499 440 16902
770225/07/08/09

PHILIPS

PHILIPS TEST & MEASURING INSTRUMENTS, INC.

85 McKEE DRIVE
MAHWAH, NEW JERSEY 07430
TELEPHONE: (201) 529-3800
TWX: 710 988-5348

Certificate of Calibration

This is to certify that the following equipment

Model Number PM3234

Serial Number DQ16-708

Job Number J2864

has been tested and inspected prior to shipment and has been found to be operating within the Manufacturer's Stated Specifications.

This calibration is traceable to the National Bureau of Standards through calibration certificates which are on file subject to examination.

Calibration Date June 22, 1987

Signed

CALIBRATED AT:

☒ 85 McKee Drive
Mahwah, N.J. 07430

☐ 12882 Valley View Street
Suite 9
Garden Grove, California 92645

☐ 1850 Lee Road
Suite 328
Winter Park, Florida 32789

☐ 800 West Cummings Park
Suite 2500
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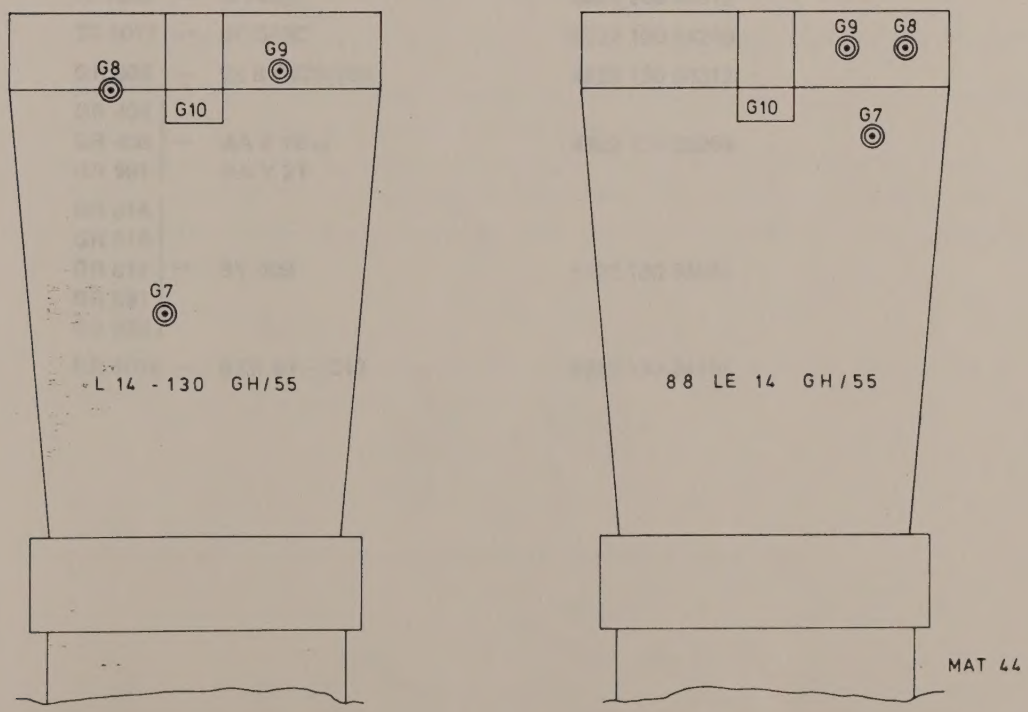
equipment for science and industry

OSCILLOSCOPE PM 3234

Already published: OSC 13

Subject: Cathode ray tube.

When ordering service ordering number 5322 131 24027 you will receive one of two different C.R.T. types, the well-known L 14-130 GH/55 type or the 88LE 14GH/55 type.
These tubes are interchangeable. Only the connection points of the collimator G7 (yellow wire), the collector mesh G8 (red wire) and the storage mesh G9 (black wire) have a different location on the C.R.T. (see figure).



9499 448 10011
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ALTERATION SHEET
PM 3243 Publ. nr. 9499 440 16902

– The correct C.R.T. Typenumber is L 14 – 131 GH/55	5322 131 24027
– Plastic cover for mains cable compartment	5322 447 94478
– Hook for C.R.T.	5322 492 64637
– Rubber for C.R.T.	5322 466 64183
– Automatic brightness control unit item 71 on page 121 should be	5322 216 54184
– Grey aluminium side strip	5322 466 85794
– Between C37 and –12V a resistor R55 (51K) is mounted	4822 110 60153
– Between C237 and –12V a resistor R 255 (51K) is mounted	4822 110 60153
– A capacitor C 1030 of 22 pF is mounted in parallel with R 1136	4822 122 31063
– R 701 → 8K2	4822 110 63132
R 825 → 1K5	4822 110 63098
IC 1002 → N 7426	5322 209 84512
TS 1017 → BC 549C	5322 130 44246
GR 803 → 2x BY 225/200	4822 130 50312
GR 404, GR 406, GR 501 → AA Z 18 or AA Y 21	4822 130 30084
GR 814, GR 816, GR 817, GR 831, GR 833 → BY 409	5322 130 34594
GR 1018 → BZX 61 – C13	5322 130 34107

SERVICE
Scientific & Analytical Equipment
Test & Measuring Instruments
Industrial Controls
Welding
Industrial Data-processing Systems

Scientific & Industrial Equipment Division

OSCILLOSCOPE PM 3234

Already published: OSC 13 - OSC 26.
Subject: Flash-over problem inside C.R.T.

– In some instruments flash-over inside the C.R.T. occurs.
The C.R.T. display remains then more or less green instead of just black, after pushing the ERASE-button.

DON'T REPLACE THE C.R.T. unless you have tried the following modification.
In most cases a solution to this problem can be found by replacement of the E.H.T. unit by a modified one.
This modified type of E.H.T. unit has a reduced internal resistance (Ri).

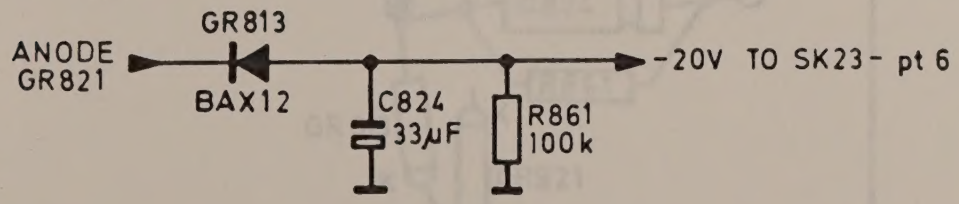
The modified E.H.T. unit will be delivered under the old service ordering number: 5322 216 54109 and can be recognized by the number 4022 246 0235 which is printed on its housing.
(The new unit can also be used for service replacement in older instruments.)

Note: After replacement of a C.R.T. or an E.H.T. unit the instrument must be checked and adjusted again.

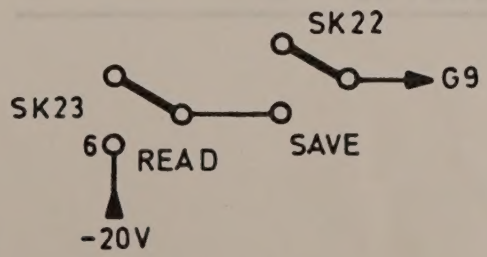
– During the production of the /12 version a modification is introduced to increase the memory off voltage from −30 V to −50 V, because of changed C.R.T. specification.

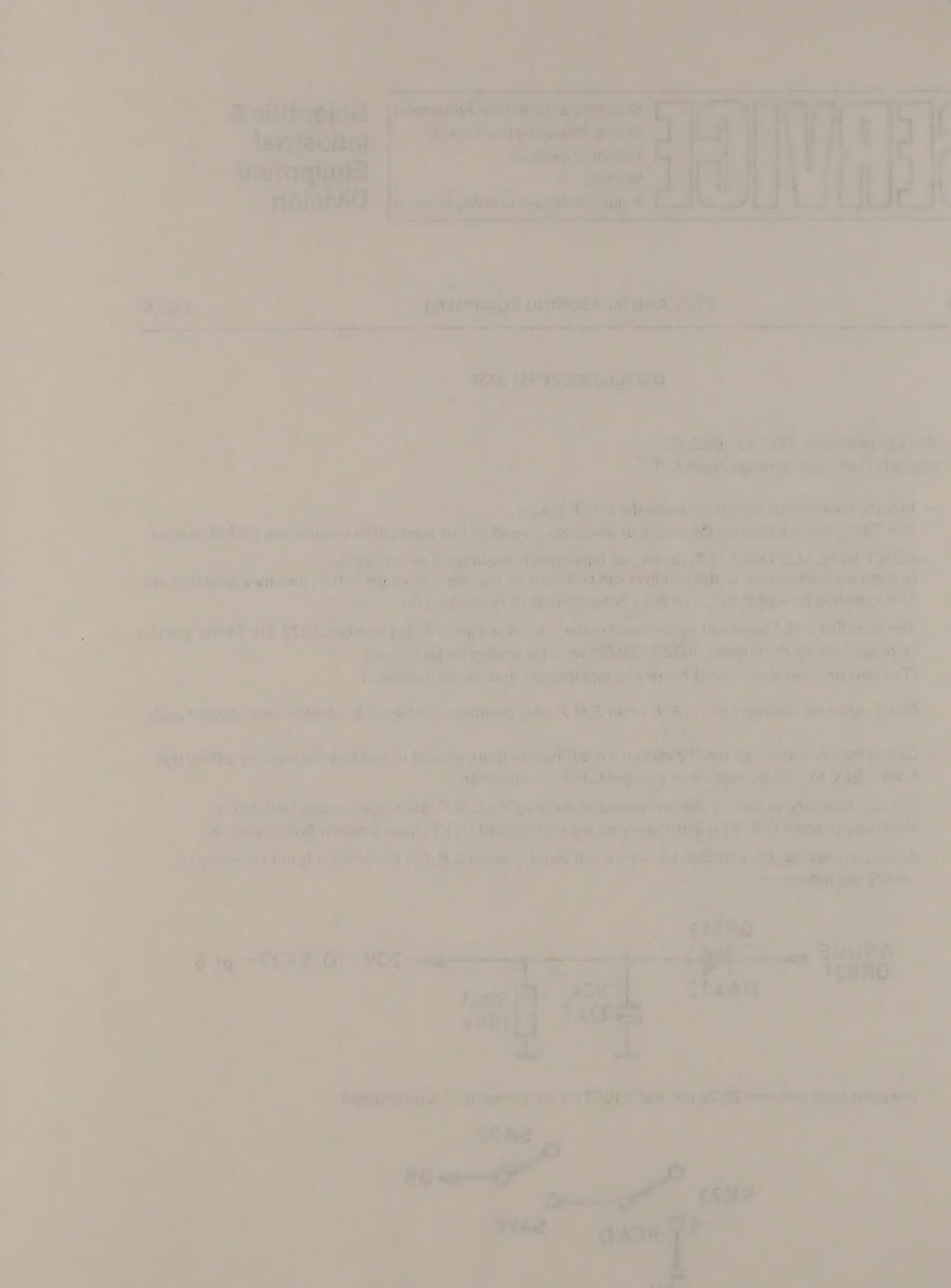
It is not necessary to modify the instrument in this way if a C.R.T. has to be replaced UNLESS a modification sheet OSC 61 is accompanying the replacement C.R.T. from Concern Service Centre.

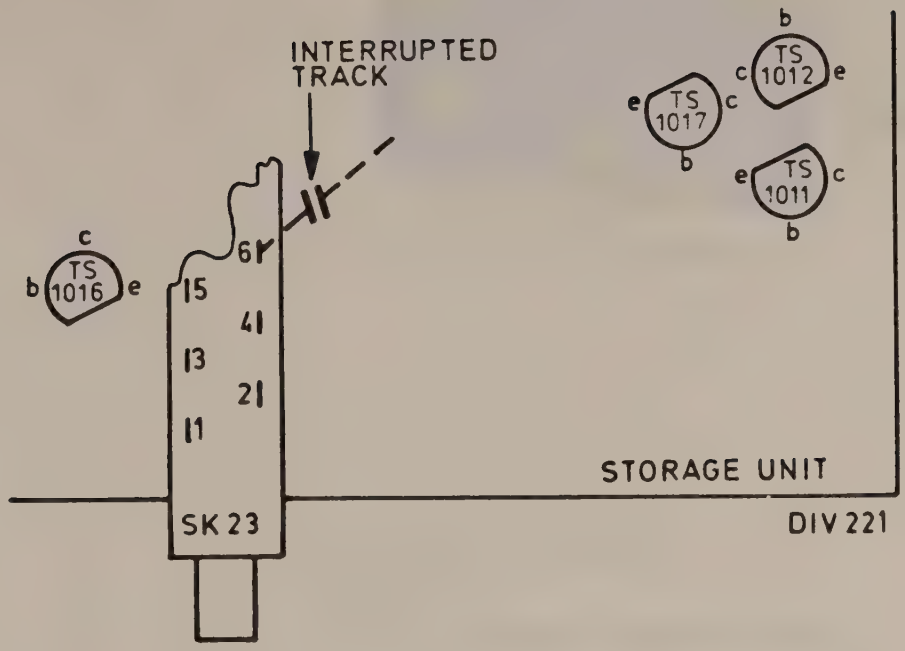
As long as possible, Concern Service Centre will deliver, tested C.R.T.'s for which it is not necessary to modify the instrument.

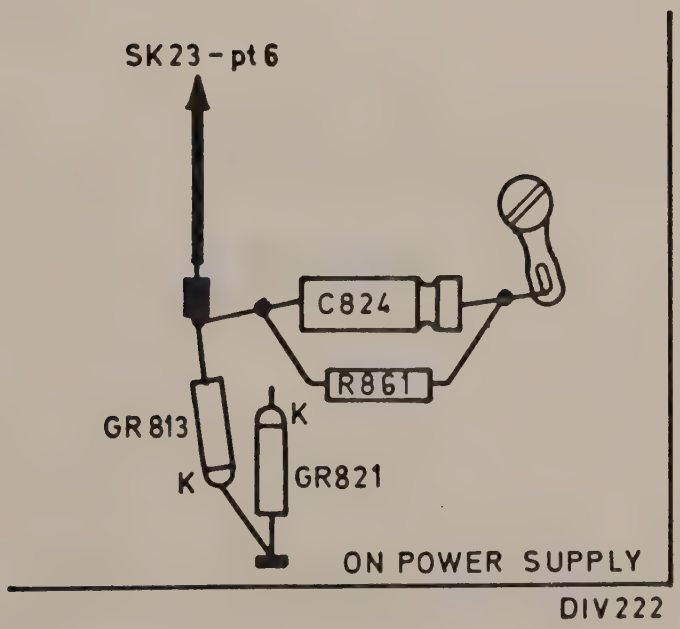


The print track between SK23 pt6 and R1043 on the storage unit is interrupted.

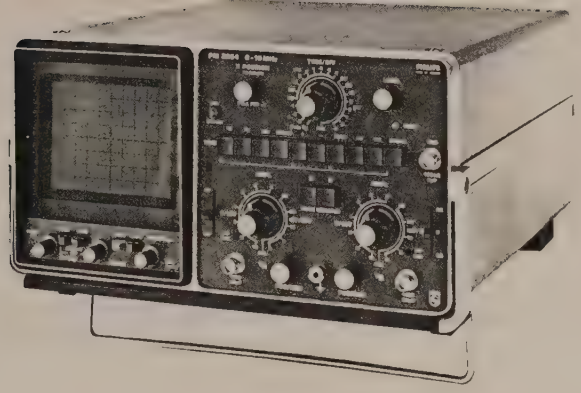





INTERRUPTED
TRACK
TS
1016
TS
1012
TS
1017
TS
1011
6
15
41
13
21
11
SK 23
STORAGE UNIT
DIV 221


SK 23 - pt 6
C824
R861
GR 813
K
K
GR821
ON POWER SUPPLY
DIV 222

PHILIPS



Instruction manual
Anleitung
Notice d'emploi et d'entretien

10 MHz DUAL - BEAM STORAGE OSCILLOSCOPE
10 MHz ZWEISTRAHL - SPEICHEROSZILLOGRAF
10 MHz OSCILLOSCOPE DOUBLE TRACE A MEMOIRE

PM3234

(9444 032 34...)

PHILIPS

ordering number
of this manual: 9499 440 16902

770225/07/08/09

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate at the bottom of the instrument.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Unterseite des Geräts.

IMPORTANT

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques fixée sur la plaque de fond de l'appareil.

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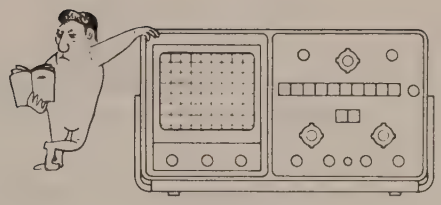
Operating manual

1. GENERAL INFORMATION



1.1. Introduction

The 10 MHz Dual-beam storage Oscilloscope PM 3234 has been designed for general laboratory, service and educational applications.
Both vertical amplifiers are equipped with a drift-reduction circuit, a delay line and a fully protected field-effect transistor input. All circuits are entirely transistorized and the transistors have been mounted on supports to enable quick servicing.
The instrument can be supplied from either a.c. mains or external d.c. sources.
Waveform are stored in the PM 3234 by using a conventional electron gun assembly to form a charge pattern on the surface of a storage layer. This pattern can be maintained for a considerable period of time, even when the apparatus has been switched off.
The length of time that a stored image remains displayed depends upon the degree of display brightness used, and can be longer than two hours. It is possible to store several single shot waveforms in order to display them simultaneously.
An erase facility enables stored information to be cancelled immediately at will.

The PM 3234 also incorporates a feature which enables display persistence to be varied over a wide range. This enables a stable display of repetitive slow-speed signals without flicker effects. The variable persistence feature also enables fast h.f. signals to be displayed. In this case, several cycles are used to develop the image on the memory layer so that a clear display can be obtained. Such displays may be obtained using signals with repetition rates as low as one cycle per minute. Single shot signals which are normally too fast for display by a conventional oscilloscope may be written by means of a 'max. write' facility. Because of the high degree of sensitivity involved in this mode of operation, display quality is slightly degraded.

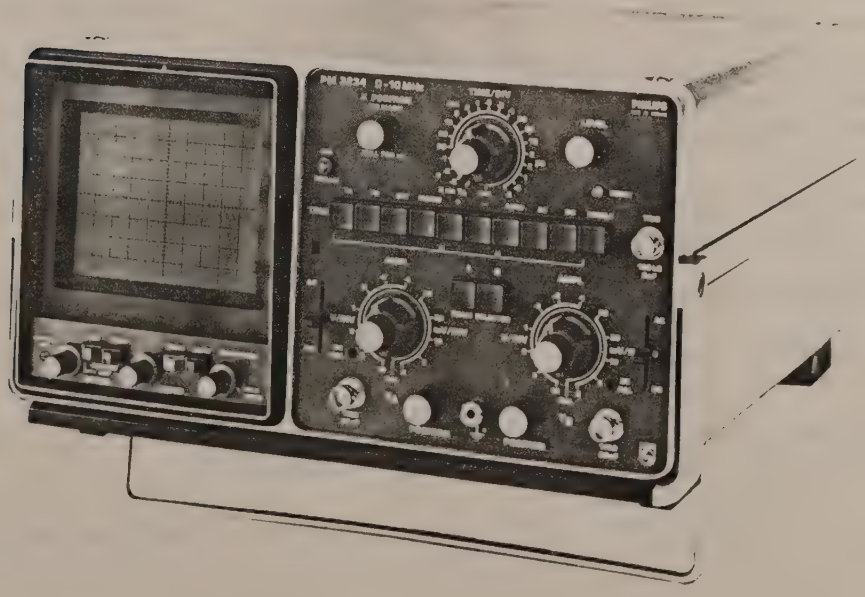


Fig. 1.1. Dual-beam storage oscilloscope PM 3234

1.2. Characteristics

Properties expressed in numerical values with stated tolerance are guaranteed for nominal mains voltages. Numerical values without tolerances are typical values representing the characteristics of an average instrument.

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.1. C.R.T.		
Type	PHILIPS L14-130GH	Split-beam tube, mesh type, post-accelerator, metal-backed phosphor, half-tone storage
Measuring area	8x10 divisions	1 div. equalling 0,9 cm
Screen type	P31 (GH) phosphor	
Total acceleration voltage	8,5 kV	
Overlap of the two systems	100 %	Both in horizontal and vertical direction
Graticule	Internal	
Engravings	8x10 divisions with sub-divisions along the central axes. Dots indicate 10 % and 90 % of measuring lattice.	
Persistence	In MEMORY OFF mode medium short	Natural persistence of P31 phosphor
	In WRITE mode from $< 0,3$ s to $\geqslant 1,5$ min	Continuously variable
Storage time	In READ mode $\geqslant 3$ min In SAVE mode $\geqslant 15$ min	
Writing speed	$\geqslant 100$ div/ms $\geqslant 1$ div/μs	In MEMORY OFF mode In MAX. WRITE mode
Erasure	approx. 600 ms	Push-button operated
1.2.2. VERTICAL AMPLIFIERS		
1.2.2.1. Response		
Frequency range	d.c. ... 10 MHz 2 Hz ... 10 MHz	-3 dB bandwidth d.c. coupled -3 dB bandwidth a.c. coupled
Rise time	35 ns	
Overshoot	2 % at maximum	Test pulse of 10 ns rise time for 6 div deflection at 1 MHz
1.2.2.2. Deflection coefficients	2 mV/div. ... 10 V/div.	Twelve calibrated positions in 1-2-5 sequence. Uncalibrated continuous control $1 : \geqslant 2,5$
1.2.2.3. Error limit	± 3 % ± 5 %	In range +5 °C ... +40 °C In range -10 °C ... +55 °C
1.2.2.4. Maximum permissible input voltage	± 400 V	d.c. + a.c. peak

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.2.5. Instability of the spot position		
Long-term drift = short-term drift	0,25 div/hour	Typical value
1.2.2.6. Vertical positioning	16 div	
1.2.2.7. Dynamic range	24 div	Peak-to-peak amplitude for sine-wave signals; up to 3 MHz negligible distortion
1.2.2.8. Input impedance	1 MOhm/20 pF	
1.2.2.9. Input RC time	0,1 s	Coupling switch to A.C.
1.2.2.10. Visible signal display	$\geqslant$ 40 nsec	Difference between the channels 0,1 division
1.2.3. X-Y MODE	X via Y_A	x5 magnifier inoperative
Horizontal frequency range	d.c. ... 1 MHz 2 HZ ... 1 MHz	
Phase shift	5^o 1^o	At 100 kHz At 10 kHz
Additional error for Y_A channel	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4. TIME BASE		
1.2.4.1. Time coefficients	0,5 s/div ... 0,2 µs/div	Twenty calibrated positions in 1-2-5 sequence Uncalibrated continuous control 1 : $\geqslant$ 2,5
1.2.4.2. Coefficient error	± 5 %	In range −10 °C ... +55 °C
1.2.4.3. Expansion		
Magnification	5x	Switched, calibrated
Additional error	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4.4. Time-base output signal		
Output voltage	300 mV	With 50 Ohm termination
Emf (open output voltage)	6 $V_{p\text{-}p}$ (−2 V to +4 V)	The output terminal may be short-circuited without affecting the time coefficients
Internal resistance	1 kOhm	
1.2.4.5. Positioning range	The beginning and the end of the time-base line can be made visible	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.5. TRIGGERING		
1.2.5.1. Source	Internal: channel Y_A, channel Y_B or mains freq. External	
1.2.5.2. Trigger sensitivity	Internal $\leqslant$ 1 div at 10 MHz External $\leqslant$ 1 $V_{p\text{-}p}$ at 10 MHz	For sine-wave signals
1.2.5.3. Input impedance	100 kOhm//5 pF	
1.2.5.4. Maximum permissible input voltage	± 400 V	d.c. + a.c. peak
1.2.5.5. Trigger mode	Auto A.C. D.C. Single	20 Hz ... $\geqslant$ 10 MHz 10 Hz ... $\geqslant$ 10 MHz 0 Hz ... $\geqslant$ 10 MHz
1.2.5.6. Level range	Corresponding to trace height 24 div 24 V	In the automatic mode In the A.C., D.C. and single mode External
1.2.5.7. Triggering frequency range	10 Hz ... 10 MHz d.c. ... 10 MHz 20 Hz ... 10 MHz	A.C. coupling D.C. coupling A.C. coupling in the automatic mode
1.2.5.8. Triggering slope	+ or –	
1.2.6. CALIBRATION GENERATOR		
Type	Square-wave generator	
Output voltage	600 $mV_{p\text{-}p}$	
Accuracy	± 1 %	In range +5 °C ... +40 °C
Frequency	approx. 2 kHz	
1.2.7. OPERATING CONDITIONS		
1.2.7.1. Supply	a.c. or d.c.	
Nominal voltage range (on mains voltage adaptor)	a.c. 90 V ... 140 V 180 V ... 265 V d.c. 22 V ... 30 V	
Nominal frequency range	46 Hz ... 400 Hz	
1.2.7.2. Ambient temperature		
Rated range of use	+5 °C ... +40 °C	
Limit range of operation	–10 °C ... +55 °C	
Storage and transport conditions	–40 °C ... +70 °C	
1.2.7.3. Operating position	Any	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.8. **WARM-UP TIME**	5 minutes	At constant ambient conditions (not including recovery time; see also section 2.1.6.)
1.2.9. **POWER CONSUMPTION**	61 VA at 220 V a.c. 30 W at 24 V d.c.	 1,25 A current drain
1.2.10. **MAINS INTERFERENCE**	The instrument meets the VDE Storgrad K requirement	
1.2.11. **MECHANICAL DATA**		
Design	Portable	
Dimensions	Depth 503 mm Width 326 mm Height 185 mm	Incl. front cover Incl. handle Incl. feet
Weight	Approx. 11,5 kg	
1.2.12. **COOLING**	Natural convection	
1.2.13. **COMPONENT REPLACEMENTS**	Normal production types, transistors plugged in	

1.3. Accessories

1.3.1. STANDARD ACCESSORIES

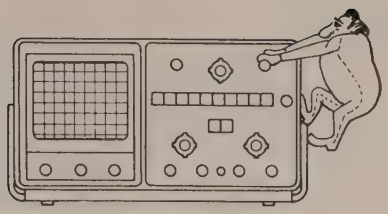
1 Front cover with storage space for two passive probes and two BNC-4 mm adapters
2 BNC-4 mm adapters PM 9051
1 Manual

1.3.2. OPTIONAL ACCESSORIES

Passive probe sets (10 : 1)	: PM 9326 and PM 9327
Passive probe sets (10 : 1)	: PM 9336 and PM 9336L
Passive probe sets (1 : 1)	: PM 9335 and PM 9335L
2 kV passive probe set (100 : 1)	: PM 9358
Probe power supply	: PM 9346
Active micro-miniature probe (10:1)	: PM 9352
Active FET probe (2 : 1)	: PM 9353
Current probe	: PM 9355
Set of miniature probe clips	: PM 9333
Multi-purpose oscilloscope camera	: PM 9380
Adapter (oscilloscope to camera)	: PM 9379
19" rackmount set	: PM 9359

See also chapter 3.5. "Information concerning accessories".

2. DIRECTIONS FOR USE



2.1. Installation

2.1.1. REMOVING AND FITTING THE FRONT COVER

Removing : – Turn the knob in the centre of the cover a quarter of a turn anti-clockwise
– Take the cover off

Fitting : – Align the key of the locking knob with the slot in the text plate of the instrument
– Fit the cover over the front of the oscilloscope
– Press the knob and turn it a quarter of a turn clockwise

WARNING

This instrument generates high voltages and should not be operated with the covers removed. The mains plug or external voltage source should be removed before attempting any maintenance work, and any relevant high voltage points dischanged.

2.1.2. ADJUSTING TO THE LOCAL MAINS SUPPLY AND FUSES

Before switching-on, the instrument must be adjusted to the local mains voltage by means of the voltage adapter at the rear of the instrument.
It is possible to adjust the instrument to 110 V, 127 V, 220 V and 240 V by means of a screwdriver.
The selected voltage is visible through the opening at the rear.
The instrument can optionaly (Spec. transformer) be adapted for 100 V, 120 V, 200 V and 220 V.
The fuse holder on the rear panel normally carries a 400 mA delayed action mains fuse but if the instrument is to be connected to a mains voltage of less then 200 V, a 800 mA fuse must be fitted.
Check that the fuse is of the specified type and current rating before connecting the oscilloscope to the mains.
The use of repaired fuses and the short-circuiting of fuse holders is prohibited.

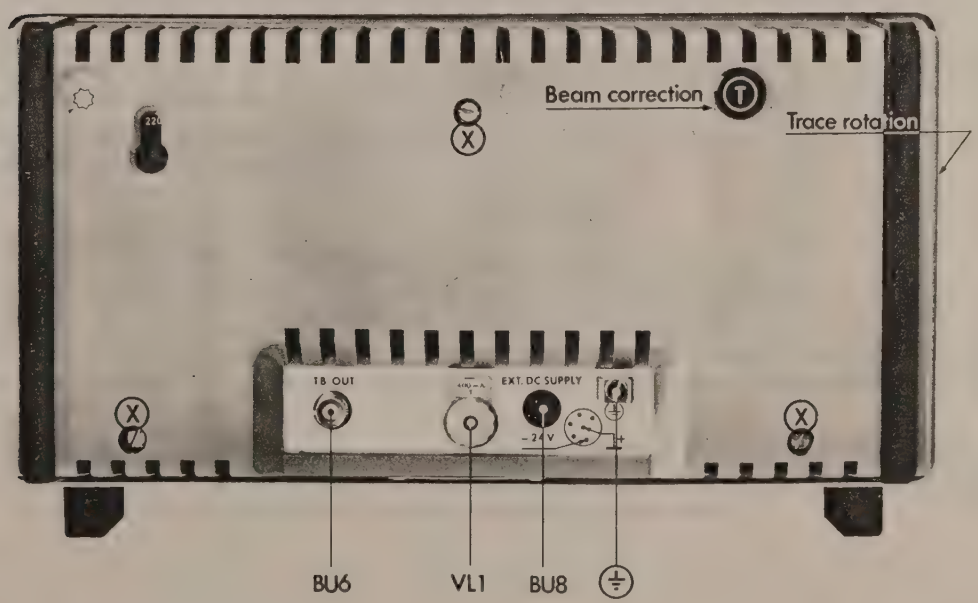
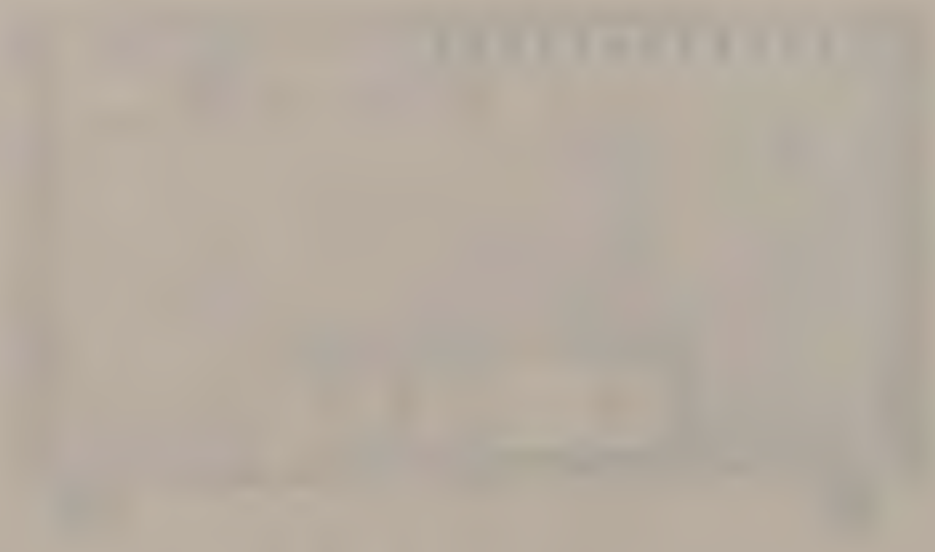


Fig. 2.1. Rear view showing sockets



2.1.3. SUPPLY FROM AN EXTERNAL D.C. SOURCE

The instrument may be supplied from an external d.c. source of 22 V to 30 V, 1,25 A. This voltage is to be applied to EXT. D.C. SUPPLY socket BU8. THE POSITIVE TERMINAL OF THE VOLTAGE SOURCE MUST BE CONNECTED TO EARTH, AS INDICATED IN THE DIAGRAM ON THE REAR TEXT PLATE, SINCE THE POSITIVE SIDE OF THE POWER SUPPLY IS CONNECTED TO CHASSIS.
The instrument is protected against reverse connection. In the case of external d.c. supply, the instrument is protected by fuse VL802 (Fig. 2.2) which is located on the power supply board and accessible after removing the rear cover. VL802 is a delayed action 1,6 A fuse.

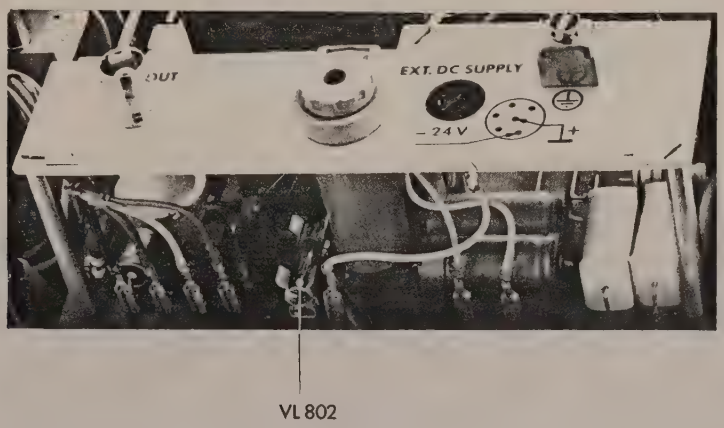


Fig. 2.2. Rear view showing fuse VL802

2.1.4. EARTHING

In the interest of safety, the oscilloscope must be connected to earth via the rear earthing terminal (identified by the symbol ⏚) or via the mains lead, provided that the supply socket is equipped with an earth connection. Care must be taken that the earth line to the oscilloscope is not interrupted due to the use of an extension lead or device which is not fitted with an earth conductor.

2.1.5. SWITCHING ON

The instrument is switched on in case of mains supply, by means of the mains switch incorporated in the INTENS control. The mains cable is located in a compartment at the bottom of the instrument.

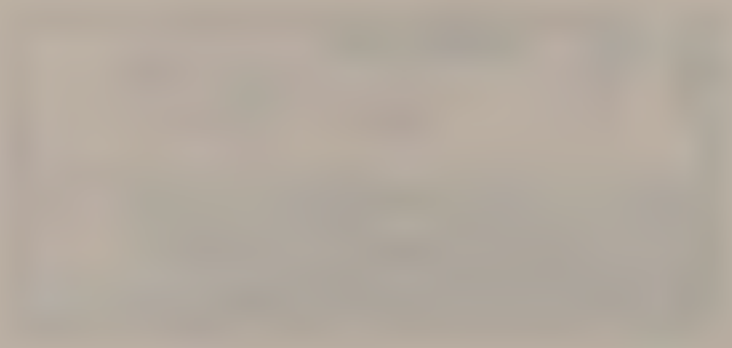
In case of external d.c. supply, the mains switch is inoperative and the instrument is on as soon as the external source is connected. In both cases, the ON position is indicated by the white pilot lamp.

The instrument may be used in any position, but care should be taken that a free air circulation is not impeded. For temperature conditions refer to section 1.2.7.2.

2.1.6. FROM THE COLD INTO THE WARMTH

In section 1.2. Characteristics you can read that the instrument works within the specifications after a warm-up period of five minutes and at an ambient temperature between +5 °C and +40 °C.
There is, however, one exception. If you leave, for instance, your oscilloscope in your car overnight when it is freezing and then bring it into a room with a temperature of 25 °C the following morning, condensation will occur on the components.

The high-ohmic resistors in your oscilloscope then cease to be high-ohmic because of leakage currents caused by the condensation, and the oscilloscope does not work properly. In this situation, you must allow approximately 2 hours for your oscilloscope to acclimatize until all condensation has evaporated.



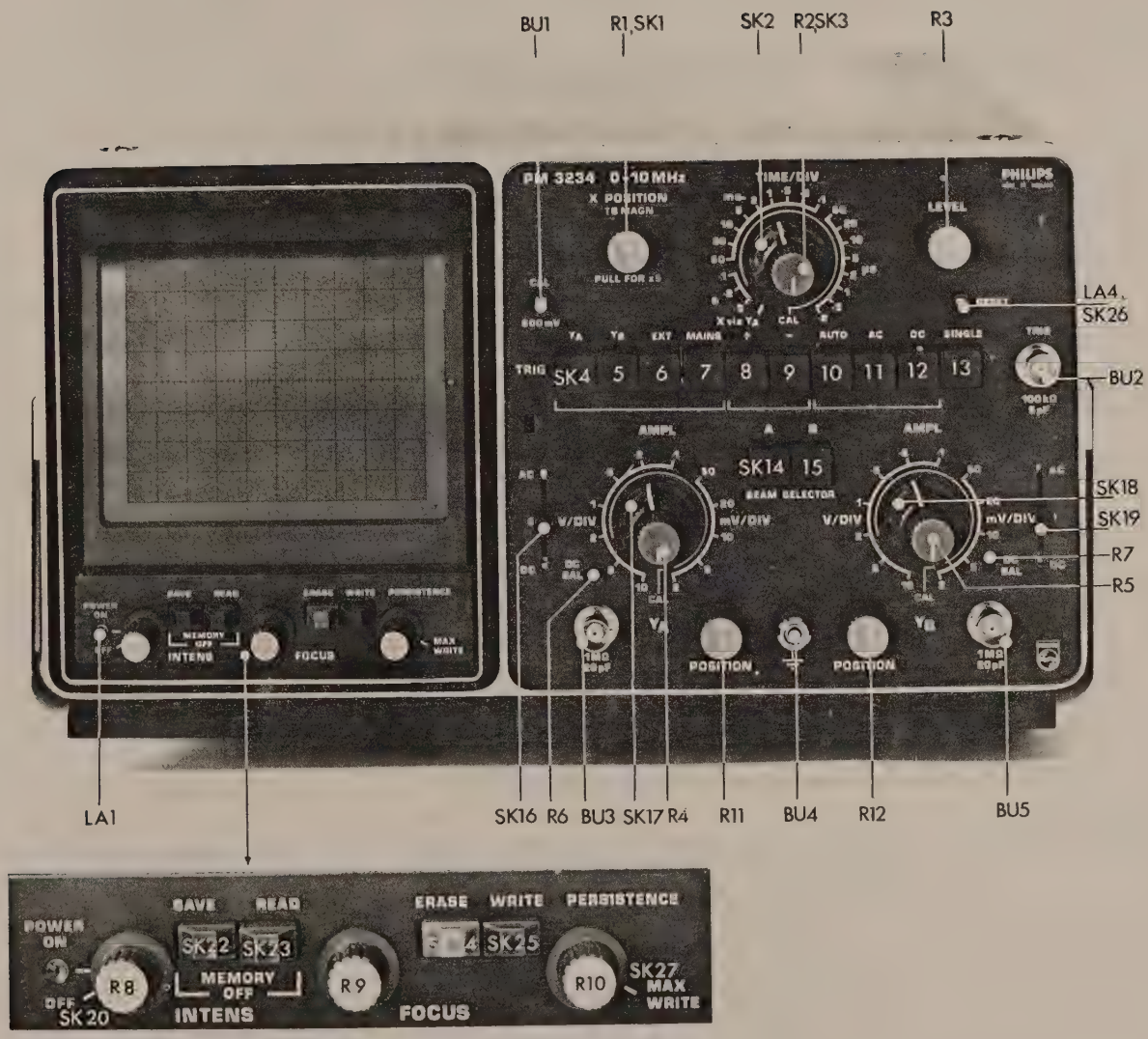


Fig. 2.3. Front view showing controls and sockets

2.2. Operating instructions

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with chapter 2.1. Installation, and that the precautions outlined have been observed.

2.2.1. CONTROLS AND SOCKETS (Fig. 2.3.)

X POSITION (R1) MAGN' (SK1)	Continuously variable control giving horizontal positioning of the display. Incorporates a switch for calibrated 5x magnification of the time base.
TIME/div (SK2)	Time-coefficient control of the time-base; 21-way switch with a position for external X deflection (X via Y_A).
CAL. - TIME/div (R2/SK3)	Continuously variable control of the time coefficients. In the CAL. position the time-coefficient is calibrated.
LEVEL (R3)	Continuously variable control to select the level at which the time-base generator starts.
CAL. (BU1)	Outlet for square-wave voltage of 600 mV_{p-p} for calibration purposes.
TRIGGERING (SK4...13)	Controls for trigger source, slope and mode; 10-way push-button switch.
Y_A (SK4)	Internal triggering signal derived from channel Y_A.
Y_B (SK5)	Internal triggering signal derived from channel Y_B.
EXT. (SK6)	Triggering signal derived from a voltage applied to the TRIGG. input socket.
MAINS (SK7)	Triggering signal derived from an internal voltage with mains frequency. This trigger source is inoperative when the instrument is supplied with an external d.c. voltage.
+ (SK8)	Provides for triggering on the positive slope of the signal.
– (SK9)	Provides for triggering on the negative slope of the signal.
AUTO (SK10)	Provides for a free-running time-base in the absence of triggering signals. and automatic signal-derived limitation on the LEVEL control range.
AC (SK11)	Triggering with coupling capacitor in triggering-signal path.
DC (SK12)	Direct coupling for triggering on a slowly varying voltage or for full-bandwidth working.
SINGLE (SK13)	If this push-button is depressed, the instrument operated in the SINGLE sweep mode.
RESET (SK26)	If switch SINGLE is in the depressed position, the time-base runs only after pressing the RESET button upon receipt of a trigger pulse.
TRIGG. (BU2)	Input BNC socket for external triggering signals.
BEAM SELECTOR A (SK14)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_A input.
BEAM SELECTOR B (SK15)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_B input. If both switch A (SK14) and switch B (SK15) are depressed, vertical deflection is achieved by both the signal connected to the channel Y_A input and the signal connected to the channel Y_B input.
AC-0-DC (SK16 & 19)	Signal coupling, three position switch. AC : via coupling capacitor O : interruption of connection between input socket and input circuit, the latter being earthed. DC : Direct coupling.

AMPL. (SK17 & 18)	Control of the vertical deflection coefficients, 12-way switch.
CAL. - AMPL. (R4 & 5)	Continuously variable control of the vertical deflection coefficients. In the CAL. position, the deflection coefficient is calibrated.
DC BAL. (R6 & 7)	Continuously variable control of the direct-voltage balance of the vertical amplifier.
INTENS (SK20 & R8)	Continuously variable control of the trace brilliance Incorporated mains switch.
SAVE (SK22)	To store the recorded waveform for a longer viewing time (protected against accidental erasure).
READ (SK23)	To observe the recorded waveform (protected against accidental erasure).
MEMORY OFF (i.e. SAVE and READ pushed simultaneously)	Allows operation of the instrument as an ordinary oscilloscope.
FOCUS (R9)	Continuously variable control of the electron-beam focusing.
ERASE (SK24)	Erases the stored display, except in the SAVE and READ mode when ERASE is disabled.
WRITE (SK25)	To record the waveform; in this mode PERSISTENCE (R10) is operative.
PERSISTENCE (R10 & SK27)	Permits variable retention of the recorded waveform. Incorporates MAX. WRITE switch.
MAX. WRITE	To increase the writing speed by a factor of approx. 10..
1 MOhm - 20 pF (BU3 & 5)	Input BNC socket for the vertical deflection signals.
POSITION (R11 & 12)	Continuously variable control giving vertical positioning of the display.
⏚ (BU4)	Earth socket.

At the rear of the instrument (Fig. 2.1.):

TB OUT (BU6)	Sawtooth output BNC socket.
TRACE ROTATION (R813)	Adjusts trace to align with the horizontal graticule lines.
EXT. DC SUPPLY (BU8)	Input socket for d.c. supply.
SCREW T	To equalize brightness of both traces.

2.2.2. PRELIMINARY SETTINGS

We recommend to allow a warm-up time of five minutes before you start your measurements. This warm-up time does not include a recovery time when the instrument comes in from the cold (see also section 2.1.6.).

– In case of mains operation:
  Check that the mains voltage adapter indicates the local mains voltage. If necessary, set the adapter to the relevant voltage in accordance with 2.1.2.
  Switch on the instrument.
– In case of external d.c. supply:
  Check that the external source is properly connected, with the positive terminal to earth.

CAUTION
EXTENDED HIGH INTENSITY MAY DAMAGE THE CRT

In the "Variable persistence" mode of operation, the CRT itself warns for too high an intensity by "blooming". When "blooming" occurs, intensity should be reduced by turning knob INTENS, R8, slightly counter-clockwise.

In the "MEMORY-OFF" and "X-Y" mode of operation, such indication does not occurs, so special care should then be taken.

2.2.2.1. Use as an ordinary oscilloscope

– The memory function of the CRT can be switched off by simultaneously pushing button SAVE, SK22, and READ, SK23. (MEMORY OFF position).
– Set FOCUS control R9 and INTENS. control R8 to their mid-positions.
– Depress BEAM SELECTOR buttons A SK14 and B SK15. Bear in mind that their will be no display if no BEAM SELECTOR button is depressed.
– Select trigger source, slope and mode. If no TRIGG. button has been depressed, the oscilloscope triggers on the Y_A signal, on the positive slope and in the AUTO mode without level range limitation.
– Display the two traces by means of Y POSITION controls R11 and R12.

The oscilloscope is then ready for use. For correction of the d.c. balance, refer to section 3.2.4.2.

2.2.2.2. Use as a storage oscilloscope

Starting from the MEMORY OFF position, when the INTENS control, R8, is adjusted for a convenient brightness of the trace and the FOCUS control, R9, is adjusted for optimum sharpness, the STORAGE mode of operation can be obtained by pushing button WRITE, SK25.

Persistence	Depending on the position of PERSISTENCE potentiometer, R10, a quickly vanishing trace will be written on a green background (R10 entirely counter-clockwise) or a slowly vanishing trace on a black background (R10 touching its first clockwise stop). The persistence can be set to suppress any flickering when displaying a low-frequency signal. For a signal with a low repetition-rate and a short rise-time, the persistence can be set so as to fill-up the trace in order to obtain a clear and steady display.
Save	If a particular trace must be retained, it can be saved by pushing button SAVE, SK22. The trace is then just visible.
Read	The intensity of the stored trace increases after pushing the READ button, SK23, but the brightness goes at the expense of storing time.
Erase	When the trace is no longer needed it can be erased by pushing button ERASE, SK24. It may happen that the trace has not entirely vanished, especially those parts which were written with a substantial brightness. This can be overcome by a prolonged actuation of the "ERASE" button.
Max. write	The writing speed can be increased by a factor of approx. 10 by putting PERSISTENCE control, R10, in its MAX. WRITE position i.e. touching its second clockwise stop, so that switch SK27 is switched over. The MAX. WRITE mode of operation is required for short sweep times or for signals with a short rise-time.

2.2.3. INPUTS Y_A AND Y_B AND THEIR POSSIBILITIES

The PM 3234 has been provided with two identical vertical channels which can be used for either YT measurements in combination with the time-base generator, or XY measurements up to frequencies of 1 MHz, and with the possibility to store the displays in different modes.

2.2.3.1. YT Measurements

To display one signal, either of the two vertical channels can be selected by operating either BEAM SELECTOR A SK14 or BEAM SELECTOR B SK15. When both push-buttons A SK14 and B SK15 are depressed, two signals can be displayed simultaneously. The Y deflection coefficient can be individually set for each channel.

2.2.3.2. XY Measurements

If TIME/div switch SK2 is set to position X via Y_A, the time base generator is switched off.
The signal of the Y_A channel is displayed horizontally. The Y_A controls, except the POSITION potentiometer R11, then control the X deflection. Positioning of the trace in horizontal sense is still possible with X POSITION control R1. The x5 MAGNIFIER switch SK1, however, is inoperative.
In this mode, XY measurements can be up to a frequency of 100 kHz.

2.2.3.3. Influence of the AC-0-DC switch

Signals to be studied can be fed to Y_A input socket BU3 and/or Y_B input socket BU5. Depending on the composition of the signal, the AC-0-DC switch should be set to position AC or DC. In position DC, the input is coupled direct to the Y amplifier. Because the Y amplifier is d.c. coupled, the entire bandwidth of the instrument is available. This means that the complete input voltages are fed to the deflection plates, which implies that the d.c. components result in trace shifts on the screen.
This may cause difficulties when a.c. signals superimposed on high direct voltages have to be displayed.
In oder to make the a.c. signal visible in those cases, a greater attenuation will be necessary with the result that the a.c. signal will also be strongly attenuated.

In this case the AC-0-DC switch can be set to position AC. Then a blocking capacitor is connected between the input socket and the Y amplifier. As a result of this, d.c. voltages are blocked, but also the lower frequencies are suppressed or attenuated. When square-wave signals of low frequency are displayed, this will result in some pulse droop.
In the 0 position of the AC-0-DC switch it is possible to quickly determine the zero volt d.c. level.
In this position the connection between the amplifier input and the input socket is interrupted, the amplifier input being earthed. At the same time, the blocking capacitor is discharged to prevent damage of the circuit under test by a possible high charge.

2.2.4. TRIGGERING

2.2.4.1. General

In order to obtain a stationary trace, the horizontal deflection must always be started at a fixed point of the signal. The time-base generator is, therefore started by narrow trigger pulses formed in the trigger pulse shaper (Schmitt trigger), controlled by a signal originating from the vertical input signal or an external source.

2.2.4.2. Trigger coupling

AC — If the signal voltage contains a d.c. component triggering can cease when the level potentiometer cannot supply the correct d.c. level for the Schmitt trigger. In this case it is useful to apply a.c. coupling. A.C. Coupling is obtained by inserting a capacitor in the trigger path. This means that the signal can still be d.c. coupled to the Y channels.

DC — D.C. Coupling is useful when the mean value of the signal varies. This sort of signal often occurs in digital systems. With a.c. coupling the trigger point would not be fixed which would give rise to jitter or even loss of triggering.

2.2.4.3. Trigger level

In case of a complicated signal in which a number of non-identical voltage shapes occur periodically, the time axis should always be started with the same voltage shape so as to obtain a stationary trace.
This is possible when one of the details has a deviating amplitude. By means of the LEVEL knob, the trigger level can be set in such a way that only this larger voltage variation passes this level. The LEVEL control is also very useful when two signals must be accurately compared e.g. in phase measurements. By means of the LEVEL control the starting point of the traces can then be shifted exactly on to the control graticule line.

2.2.4.4. Automatic triggering

Automatic triggering, when the AUTO switch is depressed, is most often used on account of its simple operation.
In this mode it is possible to display a large variety of waveforms having different amplitude and shape, without it being necessary to operate any of the trigger controls.
If no triggering signal is present, a time-base line remains visible on the screen. This is useful for zero reference purposes. In this trigger mode the level can be adjusted over the peak-to-peak value of the a.c. components of the signal. If none of the switches AUTO, AC or DC is depressed, the oscilloscope works in the automatic mode, but with the entire level range available. This has the advantage that there is always a trace visible, even when no TRIGG. push-buttons are depressed.

2.2.4.5. External triggering

External triggering is applied for signals having a strongly varying amplitude, if a signal having a fixed amplitude and equal frequency is available. Even more important is external triggering in case of complex signals and pulse patterns. Then external triggering can be used to avoid double traces.
This obviates the necessity of readjusting the level setting at every variation of the input signal.

2.2.4.6. Triggering with the mains frequency

In this case the triggering signal is a sine-wave with the mains frequency. This trigger source is useful if the frequency of the signal under observation is coupled with the mains frequency.
It is, e.g., possible to recognize the hum component of a signal by triggering on that component.

2.2.4.7. Position SINGLE and use of the RESET push-button

When effects which occur only once have to be observed, it is often desirable to ensure that only one sweep is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sweep in question must be triggered by a trigger pulse. To this end the mode switch must be put into position SINGLE. When the RESET button has been pressed, the first following trigger pulse that appears will start the time-base generator. The trace is only written once. The time-base is then blocked until the RESET push-button is again operated.
The lamp in the RESET push-button, will light up as soon as this button is operated and will go out as soon as the sweep is initiated.

2.2.5. TIME-BASE MAGNIFIER

The magnifier is operated with a push-pull switch.
When this switch is in the x5 position, the time-base sweep speed is increased 5 times. In this position the sweep time is determined by dividing the indicated TIME/div value by 5.

2.2.6. THE DUAL-BEAM STORAGE TUBE

2.2.6.1. Storage principle

The PM 3234 oscilloscope contains a cathode-ray tube with a storage mesh with variable storage time. Therefore, the c.r.t. may be used as an ordinary one, but with a variable persistence of the displayed signal.

Information is stored by writing the signal of the main electron beam into a STORAGE LAYER of non-conductive material. As a result of the secundary emission of electrons from this layer, a positive charge pattern is formed. This charge pattern on the storage surface will remain there for a considerable length of time, also if the writing gun is switched off. The trace is displayed on the phosphor viewing screen by means of a second electron beam whose electrons can strike the phosphor via the positively charged parts on the storage layer.

Storage of information on non-conductive material is based on secundary emission. Fig. 2.4. shows the ratio between the number of electrons leaving the storage layer and the number of electrons arriving (secundary emission ratio) versus the surface potential. At a certain surface potential, V_a in Fig. 2.4. the number of electrons leaving the surface equals the number of electrons arriving. This point is called the first cross-over (secundary emission ration = 1).

If the surface of the storage layer is hit by electrons of higher energy (electrons with greater velocity), the surface will become more positive, since more electrons are leaving than arriving. If the surface is hit by electrons of lower energy (electrons with lower velocity) than at V_a, the surface potential becomes more negative, as fewer electrons are leaving than arriving.

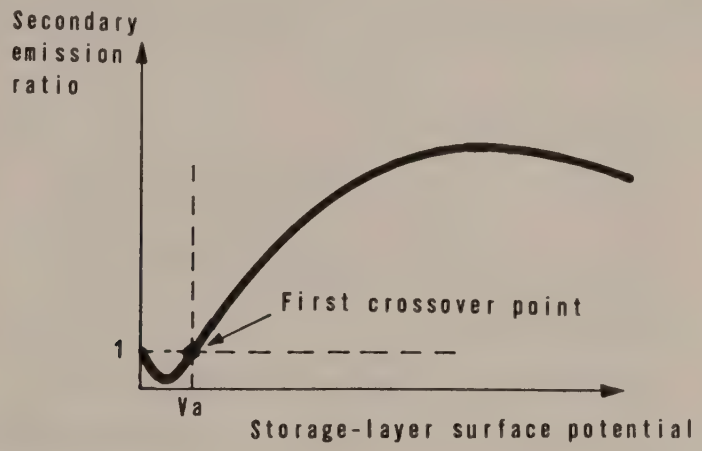


Fig. 2.4. Secondary emission ratio

2.2.6.2. Construction and operation of the storage c.r.t.

The dual-beam storage cathode-ray tube contains two systems: the WRITING system and the FLOOD system.

The dual-beam WRITING part comprises one gun in which two beams are generated that are deflected independently. This arrangement is also known as split-beam system. In this tube, both time-base lines are exactly in parallel since they originate from one point and are under the influence of one common horizontal signal amplifier. Because both traces are emitted by one gun, they show little distortion in relation to one another.

The FLOOD system consists of a pair of FLOOD GUNS operated in parallel. Both guns comprise a CATHODE c, a CONTROL GRID g1 and an ACCELERATOR GRID g2 (see Fig. 2.5.). Common to both flood guns are the FLOOD BEAM COLLIMATOR g7, the COLLECTOR MESH g8, the STORAGE MESH g9 which carries the storage layer, and the PHOSPHOR VIEWING SCREEN g10.

The flood guns are located at a point ahead of the horizontal deflection plates and the mesh. The cathode potential is approx. +30 V, this being 50 V negative in relation to the accelerator grids. Both flood gun cathodes emit a cloud of electrons. These clouds are combined by both control grids g1, accelerated by both accelerator grids g2 and shaped by the collimator g7 which consists of a coating on the inner surface of the c.r.t. bottle. The positive voltage on the collimator is such that the electron cloud emanating from the flood gun just fills the viewing area of the c.r.t.

The cloud is further accelerated in the direction of the storage mesh and the viewing screen by collector mesh g8. After passing through the collector mesh, the flood-gun electrons are controlled by the potentials on the storage mesh and storage layer surface.

A front view of the collector and storage meshes is shown in Fig. 2.6. The apertures in both meshes are approximately 40 x 40 μm. The cathode side of the storage mesh is coated with a non-conductive material on which the information is stored (see Fig. 2.7.). In other words, there exists a capacitive coupling between the storage mesh and the storage-layer surface. This capacitive coupling is essential for the proper working of the STORE and ERASE functions. The storage mesh is normally at a potential of approximately +2 V in relation to the flood-gun cathode potential, i.e. approximately +32 V with respect to earth.

The potential V_a at the storage-layer surface is controlled by WRITE and ERASE signals which are applied to the storage mesh, and varies between 2 V positive and 4 V negative in relation to the flood-gun cathode. When the storage-layer surface is at a potential of +2 V in relation to the cathode (see Fig. 2.8.), the majority of flood-gun electrons pass through the holes in the mesh and reach the phosphor screen. The remaining electrons are repelled by the storage-layer surface and collected by the collector mesh. When the potential of the storage-layer surface is negative in relation to the cathode (see Fig. 2.9.), the number of electrons passing through the storage mesh is drastically reduced or, when the cut-off level is reached, no electrons pass at all.

The post-accelerator voltage of approximately 7 kV is connected to the phosphor viewing screen. Electrons that are allowed to pass through the storage mesh are accelerated by this potential and strike the phosphor with such a velocity that a brilliant spot is obtained.

The storage-mesh may be compared to the grid of a triode. Just as the triode grid potential controls the anode current, the storage mesh controls the current of flood-gun electrons to the screen and, thus, the trace brilliance.

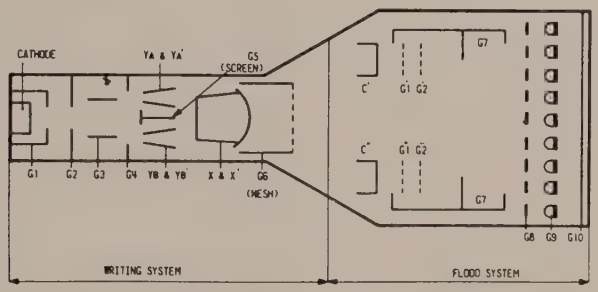


Fig. 2.5. Simplified CRT construction

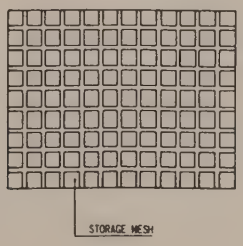


Fig. 2.6. Mesh construction used for collector and storage grids

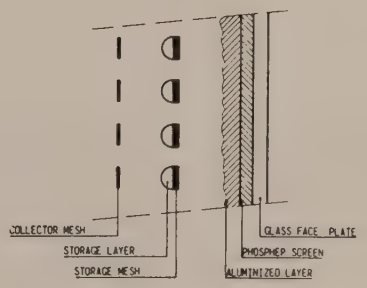


Fig. 2.7. Detail of storage system construction

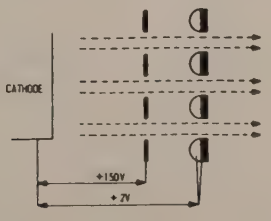


Fig. 2.8. Storage system at full brightness

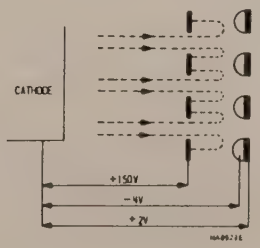


Fig. 2.9. Storage system at cut-off

2.3. Description of the block diagram

2.3.1. Y AXIS

The oscilloscope PM 3234 has two identical, d.c. coupled vertical amplifiers allowing simultaneous display of two signals. Each amplifier comprises an input step-attenuator, a source follower with protection circuitry, a pre-amplifier and a drift reduction circuit, a trigger pick-off stage, a delay line circuit and a final amplifier. Trigger pick-off stage and final amplifier (for both channels, Y_A and Y_B) have been coupled by means of the delay line circuit, which is a part of the circuitry of the delay line unit.
The protection circuitry prevents damage to the input field-effect transistors by too high sensitivity of the amplifier.

The trigger pick-off stage supplies a triggering signal to the trigger pre-amplifier in case of internal triggering, and also couples the signal to be measured to the Y final amplifier. In the Y_A channel the signal can also be coupled to the X final amplifier if the instrument is used as an XY oscilloscope. From the Y final amplifier, the signal is fed to the Y deflection plates of the c.r.t.

The delay line has been applied to enable the display of the leading edge of fast phenomena on the screen.

2.3.2. TRIGGERING

A triggering signal can be obtained from either vertical amplifier, from an external source or internally from the mains. The latter signal is not available when the instrument is supplied with an external d.c. voltage. The triggering signal is fed to a trigger pulse shaper which supplies well-defined trigger pulses to start the time-base generator. The trigger unit also comprises a single sweep circuit which causes the time-base generator to deliver one sawtooth pulse, after the RESET knob has been pressed and upon receipt of the trigger pulse. This circuit only works when switch SINGLE is depressed.

2.3.3. TIME BASE

The time-base generator is of the constant-current integrator type and supplies two output voltages.
A sawtooth voltage which is fed to the X final amplifier and an output socket at the rear of the oscilloscope and a gate pulse which controls the unblanking of the c.r.t. during the sweep.

2.3.4. X AXIS

The X final amplifier receives its input signal from either the time-base generator or from an external source via the Y_A channel. From the X amplifier the signal is fed to the horizontal deflection plates of the c.r.t. of the oscilloscope.

2.3.5. C.R.T. CIRCUITRY

The c.r.t. circuitry comprises circuits for trace blanking and unblanking, an automatic brightness control unit, circuits appertaining to the storage functions of the c.r.t. and networks for the correction of the c.r.t. characterist

The a(utomatic) b(rightness) c(ontrol) unit ensures a virtually constant trace brilliance or a blanked trace in various display modes.

In the continuous-display mode, the trace is blanked and unblanked by a signal from the time-base generator. In the single-sweep mode, the trace is blanked via the a.b.c. unit.

The storage circuits provide the voltage levels and waveforms which are necessary for the storage operation of the c.r.t.

The correction networks comprise preset potentiometers for trace rotation, astigmatism, distortion and orthogonality correction.

The high voltages for the c.r.t. are generated by a converter which also delivers the other supply voltages.

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Cryogenic Equipment / Electro Chemistry / Electron Optics / Electronic Weighing / Industrial Data Systems / Numerical Control / Philips Pollution Measuring / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analytical Equipment

equipment for science and industry

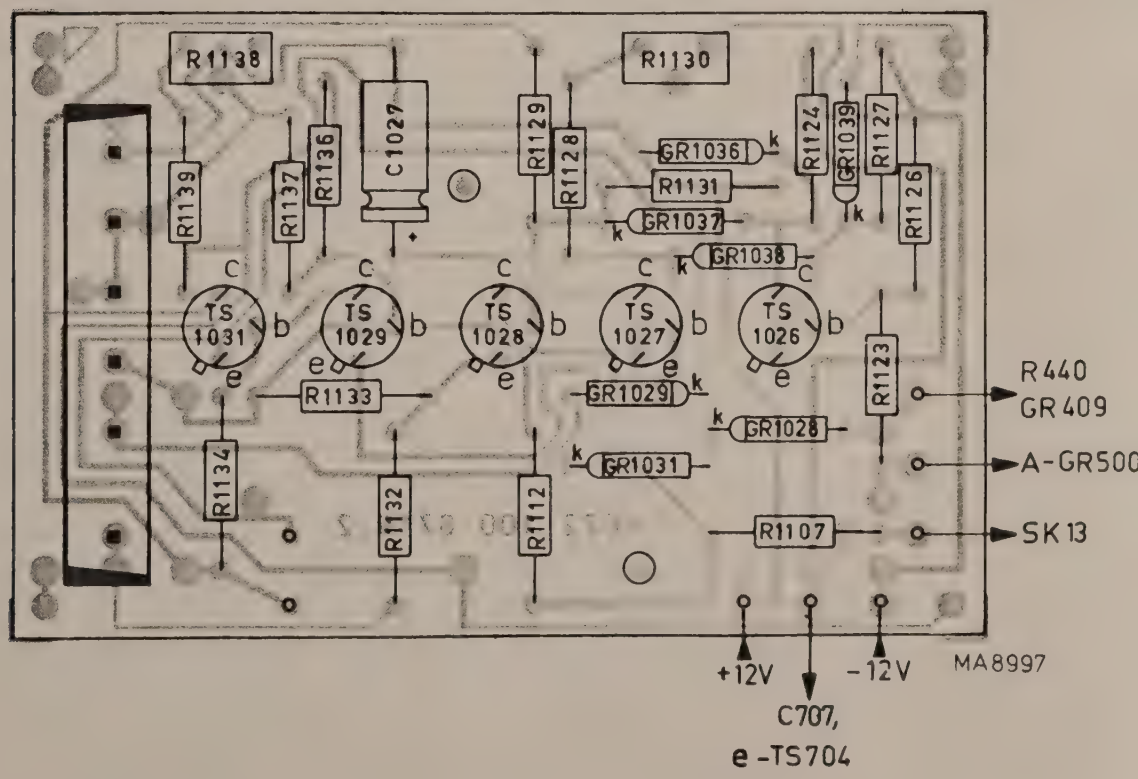
OSCILLOSCOPE PM 3234

Already published: –

Subject: Automatic brightness control unit.

During manufacturing the /06 version of the PM 3234 a new type of automatic brightness control unit is introduced.

In the PM 3234/07/08/09 manual 9499 440 16902 is still mentioned the service ordering number 5322 216 54105 (item 71 on page 121) of the old version.

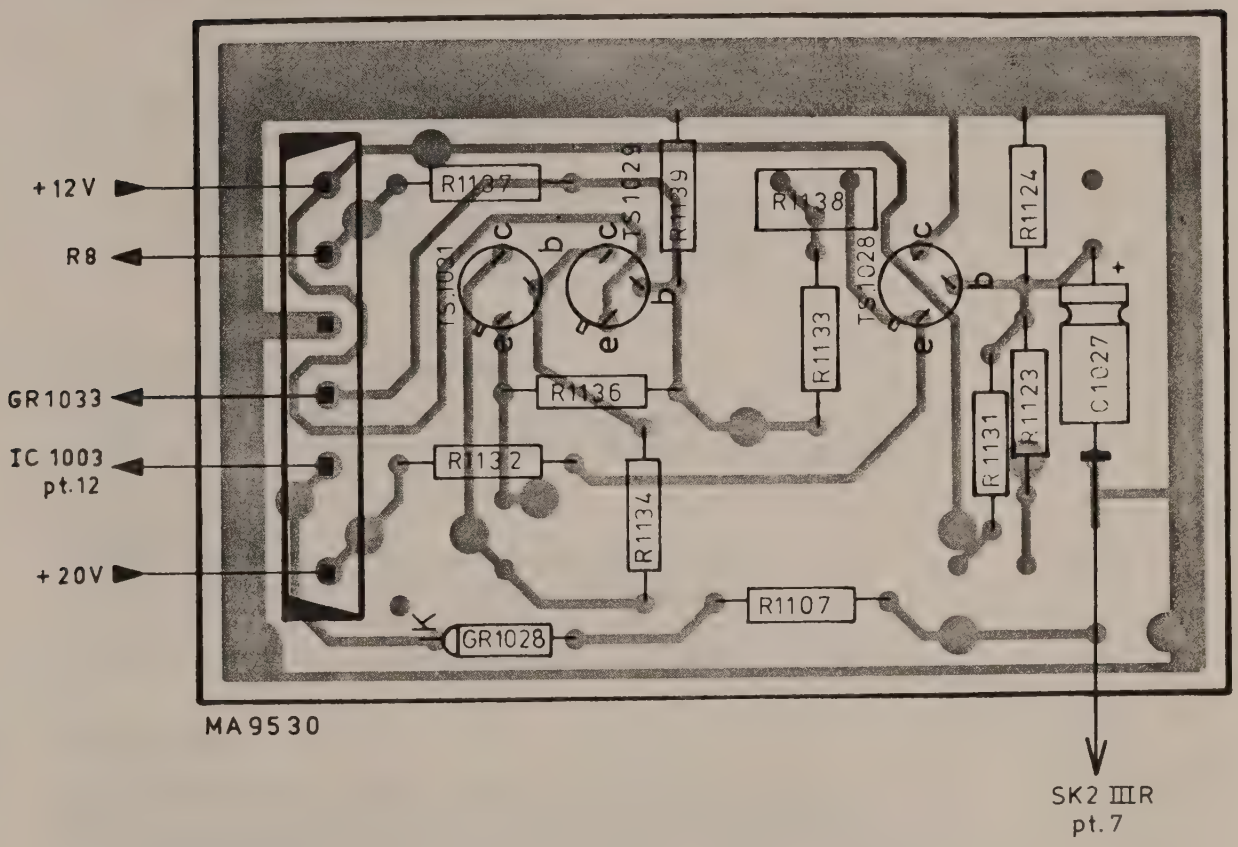


OLD VERSION

PRINTED IN THE NETHERLANDS

9499 448 08711

The new version of the automatic brightness control unit has the service ordering number 5322 216 54184



NEW VERSION

2.4. Brief checking procedure

General: Brief checking procedure is carried out in the MEMORY OFF mode.
For all storage functions refer to chapter 3.2. (checking and adjusting).

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display.
> Extended high intensity may damage the C.R.T.

2.4.1. STARTING POSITIONS OF THE CONTROLS

- Depress buttons SAVE SK22 and READ SK23 simultaneously.
- Push-buttons Y_A SK4, + SK8 and BEAM SELECTOR A SK14 & B SK15 depressed.
- TIME/div switch SK2 to .1 ms.
- AMPL switches SK17 & SK18 to .1 V/div.
- MAGN switch SK1 to x1.
- POSITION potentiometers R1, R11 and R12 to their mid-positions.
- Adjust INTENS potentiometer R8 for minimum display brightness.
- TIME/div and AMPL potentiometers R2, R4 and R5 to CAL.

Unless otherwise stated, the controls always occupy the same position as in the previous check.

2.4.2. C.R.T. POSITION

- Adjust FOCUS potentiometer R9 and INTENS potentiometer R8 for a well-defined display.
- Centre both time-base lines, using POSITION potentiometers R1, R11 and R12.
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines.
  Correction possible with potentiometer R813 (Fig. 3.16.).
- Check the brightness equality of the two beams.
  Correction possible with screw T at the rear of the instrument (Fig. 2.1.).

2.4.3. VERTICAL CHANNELS

The check for channel Y_A is described, the relevant controls for Y_B are mentioned in brackets.

- Release BEAM SELECTOR B SK15 (A SK14).
- AC-0-DC switches SK16 & SK19 to 0.
- AMPL switch SK17 (SK18) to 2 mV/div.
- Check that the time-base line remains within 0,2 div in the centre of the screen. Correction possible with DC BAL potentiometer R6 (R7).
- AC-0-DC switch SK16 (SK19) to DC.
- Check that the time-base line has not moved more than 0,4 div. Correction possible with potentiometer R126 (R326), Fig. 3.19.
- AMPL switch SK17 (SK18) to .1 V/div.
- Apply a square-wave voltage of 600 mV_{p-p} ±0,5 %, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the trace height is 6 div ±2 %.
  Correction possible with R111 (R311), Fig. 3.18.
- Increase the frequency of the input voltage to 10 MHz.
- Check that the trace height is at least 4.2 div.

2.4.4. X VIA Y_A

- Depress BEAM SELECTOR A SK14 and B SK15.
- Set TIME/div switch SK2 to X via Y_A.
- AC-0-DC switch SK19 to 0.
- Apply a square-wave voltage of 600 mV_{p-p} ±0,5 %, 2 kHz, to Y_A input socket BU3.
- Check that the trace width is 6 div ±3 %.
  Correction possible with potentiometer R601 (Fig. 3.17.).

2.4.5. TIME-BASE

- Check the time-coefficient in position 20 μs of TIME/div switch SK2 by means of time markers.
  Tolerance ±5 %. Correction possible with potentiometer R534 (Fig. 3.17.).
- Check the other time-coefficients; tolerance ±5 %.

2.4.6. TRIGGERING

- Apply a sine-wave voltage of 100 mV_{p-p}, 10 MHz, to Y_A input BU3.
- Check that it is possible to adjust LEVEL potentiometer R3 for a stationary display.

Service manual

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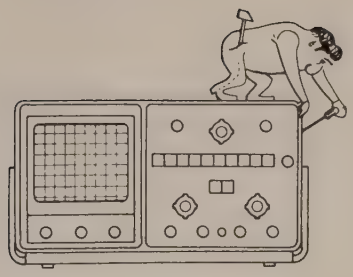
3. SERVICE DATA



3.1. Circuit description

3.1.1. CHANNEL Y_A VERTICAL AMPLIFIER

3.1.1.1. General

The vertical amplifier provides control of the input coupling, Y deflection coefficient and gain.
Furthermore, a drift-reduction circuit, a delay line and a trigger pick-off stage are part of the amplifier circuitry.

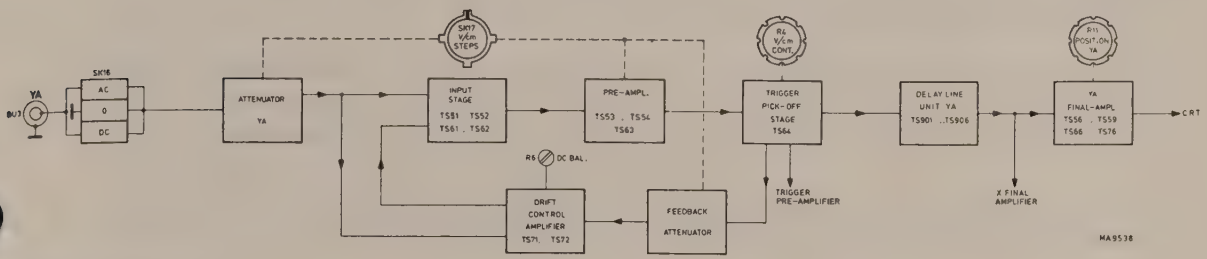


Fig. 3.1. Vertical amplifier, channel Y_A

3.1.1.2. Input coupling

Input signals connected to Y_A socket BU3 can be a.c. coupled, d.c. coupled or internally disconnected.
In position DC of AC-0-DC switch SK16, the input signal is coupled direct to the step attenuator.
In the AC position, there is a capacitor (C26) in the signal path.
This capacitor prevents the d.c. component of the input signal from being applied to the amplifier.
In position 0, the signal path between the input socket and the amplifier input is interrupted, the latter being earthed.
At the same time, blocking capacitor C26 is discharged via resistor R26, to prevent damage of the circuit under test by a possible high charge.

3.1.1.3. Input attenuator

The input attenuator is a frequency-compensated, high-ohmic voltage divider with twelve positions.
Both attenuator sections contain trimmers which are adjusted for optimum square-wave response and others that maintain the same input capacitance (20 pF) for each position of AMPL. switch SK17.
The input capacitance of both channels can be equalized using trimmer C235.
The attenuator works in conjunction with a gain control in the preamplifier (see also section 3.1.1.5.).
The gain of the pre-amplifier is selected together with the relevant attenuator section, by means of AMPL. switch SK17.

3.1.1.4. Input stage

Input source follower TS51 and emitter follower TS52 provide a high input impedance to the step attenuator and a low-impedance source to the pre-amplifier.
The input source-follower is protected by diodes GR53 and GR54 .
If there is a maximum positive-going voltage change, the field-effect transistor can deal with it. If the change goes negative beyond the threshold established by zener diode GR54, diode GR53 starts conducting and the

The non-driven part of the input stage (TS62) is decoupled for high frequencies, by means of capacitor C59. This part of the input stage receives the d.c. balance voltage and the drift-feedback voltage from the drift-feedback amplifier.

3.1.1.5. Pre-amplifier

The pre-amplifier comprises two amplifier stages, one with series feedback (TS53 & TS63) and one with shunt feedback (TS54). The overall gain of the pre-amplifier is chiefly determined by the ratio of the shunt feedback resistance (R97 & R99) and series-feedback resistance (resistance between the emitters of transistors TS53 and TS63). The latter resistance, and thus the overall gain of the pre-amplifier, can be varied by connecting resistors in parallel to resistor R62. These parallel resistors are selected, together with a section of the input attenuator, by means of AMPL. switch SK17. In this way twelve different deflection coefficients are obtained (see also section 3.1.1.3.).
Potentiometers R64 and R99 are pre-set controls for the gain of the pre-amplifier at different settings of AMPL. switch SK17.

3.1.1.6. Drift-reduction circuit

In the event of no drift phenomena in the pre-amplifier, attenuator R102, R40...R44 provides at junction R128-C67 a voltage which is exactly to, but in anti-phase with, the voltage at the gate of field-effect transistor TS51 (junction R52-R54). This is true because attenuator R102, R40...R44 is switched over together with the gain switch of the pre-amplifier. Junction R128-R52 will then be on earth level (virtual earth point).

When there is a drift phenomenon, junction R128-R52 carries half the drift voltage. This voltage is amplified by transistors TS71 and TS72 and, in the correct phase, applied to field-effect transistor TS62. The resulting feedback grings the output level of the amplifier back to 0 V. The d.c. level of the feedback is adjusted with DC BAL potentiometer R6.

In order to prevent the base currents of transistors TS71 and TS72 from flowing through high-ohmic resistors R128 and R52, they are compensated for by means of potentiometer R126 and resistors R127 and R129. Resistor R131 equalize the base impedance of transistors TS71 and TS72 .

Capacitor C59 limits the feedback at approximately 100 Hz.
Therefore, a variation of the value of potentiometers R64 & R99 causes a variation in the top of a l.f. square-wave voltage. When potentiometers R64 and R99 are correctly adjusted, the pulse top is straight.

3.1.1.6.1. Drift reduction

The drift inherent in the sensitive d.c. coupled pre-amplifier is reduced by feedback via a control amplifier. We shall now calculate the effect of the control amplifier with reference to Fig. 3.2. in which A is the gain factor of the pre-amplifier and B that of the control amplifier. Resistors R are equal.

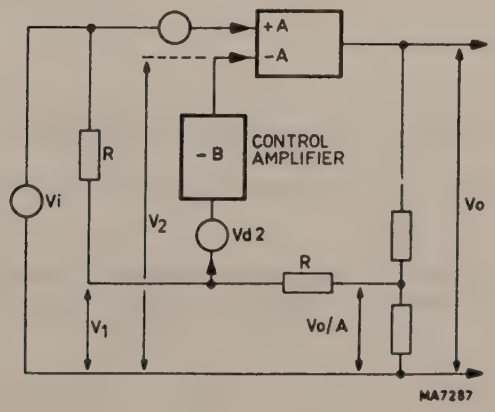


Fig. 3.2. Block diagram of the drift-reduction circuit

We regard the drift voltages from pre-amplifier and control amplifier as being due to d.c. voltage sources at the input (Vd1 and Vd2). We then find:

$$V1 = \frac{Vi + \frac{Vo}{A}}{2} \tag{1}$$

$$V2 = -B\,(V1 + Vd2) \tag{2}$$

$$Vo = A\,(V2 - Vi - Vd) \tag{3}$$

It follows from (1) and (3) that:

$$V1 = \frac{Vi + \frac{A\,(V2 - Vi - Vd1)}{A}}{2} = \frac{V2 - Vd1}{2}$$

Substituting this result in (2) gives:

$$V2 = -B\,(\frac{V2 - Vd1}{2} + Vd2) \qquad \text{or}$$

$$V2\,(1 + \frac{B}{2}) = \frac{B}{2}\,Vd1 - BVd2 \qquad \text{or}$$

$$V2 = \frac{BVd1}{2 + B} - \frac{BVd2}{1 + \frac{B}{2}}$$

Substituting this result in (3) gives:

$$\frac{Vo}{A} = (\frac{B}{2 + B} - 1)\,Vd1 - \frac{BVd2}{1 + \frac{B}{2}} - Vi \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{2}{2 + B}\,Vd1 + \frac{B}{1 + \frac{B}{2}}\,Vd2 \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{1}{1 + \frac{B}{2}}\,Vd1 + \frac{2}{1 + \frac{2}{B}}\,Vd2$$

The last two terms represent drift voltages which are equivalent to a drift voltage:

$$Vd = \frac{1}{1 + \frac{B}{2}}\,Vd1 + \frac{2}{1 + \frac{2}{B}}\,Vd2$$

at the input.

We see that the drift of the pre-amplifiers is reduced by a factor $(1 + \frac{B}{2})$. On the other hand, we have an extra drift due to the control amplifier, which is given by $\frac{2}{1 + \frac{2}{B}}\,Vd2 \approx 2Vd2$.

The drift of the control amplifier, however, is so low (because of strong thermal coupling of the amplifier transistors, and optimum design) that the term 2Vd2 can be neglected.

3.1.1.7. Trigger pick-off stage

Transistor TS64 serves a twofold purpose. It acts as an amplifier stage for the channel Y_A triggering signal further discussed in section 3.1.3.1., and as an emitter-follower for the signal to be tested.
The test signal is applied to the delay line circuit via AMPL. potentiometer R4 in the emitter circuit of transistor TS64. This potentiometer provides an uncalibrated, continuous control of the deflection coefficients.

3.1.1.8. Delay line circuit

The delay line circuit consists of an assymmetrically driven differential amplifier (TS902 & TS903), which is coupled with emitter followers (TS901, TS904 & TS906) at the input as well at the output.
Emitter follower TS906 serves the symmetry. From resistor R903 in the emitter circuit of transistor TS901 the signal is, via the delay line, applied to the differential amplifier. The delayed test signal is coupled to the output stage via emitter follower TS904, which reduces the effect of the input capacitance of the output stage on the differential amplifier.
The input of the delay line is terminated by R903/R904 and its output by R907.
Transistor TS905 acts as a constant emitter-current source for amplifier stage TS902 - TS903.

3.1.1.9. Output amplifier

From the emitter of emitter follower TS904, the signal is applied to the base of transistor TS66 which is part of a differential amplifier. By varying the series feedback of this amplifier by means of potentiometer R111, the overall gain of the Y_A channel can be set. The RC combination R113-C62 corrects the gain factor at high frequencies.

The Y shift voltage derived from POSITION potentiometer R11 is applied to the base of transistor TS67.
If BEAM SELECTOR switch SK14 is not depressed, the voltage on the base of TS67 is such that the trace is shifted off the screen and cannot be brought back with the POSITION potentiometer.

From the differential amplifier the signal is fed to the final stage which consists of two single-ended push-pull sections, viz. TS57, 58, 59, 68 and TS69, 73, 74, 76. From these two sections, the signal is applied to the Y deflection plates.
The circuit with transistor TS56 will be discussed together with the c.r.t. circuitry (section 3.1.6.2.1.).
In position X via Y_a, the signal is fed to the X output amplifier via emitter follower TS75. In this case the channel Y_A output amplifier is inoperative.

3.1.2. CHANNEL Y_B VERTICAL AMPLIFIER

As this channel is identical to channel Y_A with the exception of the circuitry for external X deflection, the description of channel Y_A also holds good for channel Y_B. Components are assigned in the 200-299 range (corresponding to numbers in the 1-99 range for channel Y_A), in the 300-399 range (corresponding to range 100-199 in channel Y_A) and in the 1000-1099 range (corresponding to range 900-999 in channel Y_A).

3.1.3. TRIGGERING

The trigger unit comprises the following circuits:
a trigger pre-amplifier, a differential amplifier, trigger mode selector and a trigger-pulse shaper.
The circuit diagram shows all triggering push-buttons in their released positions.

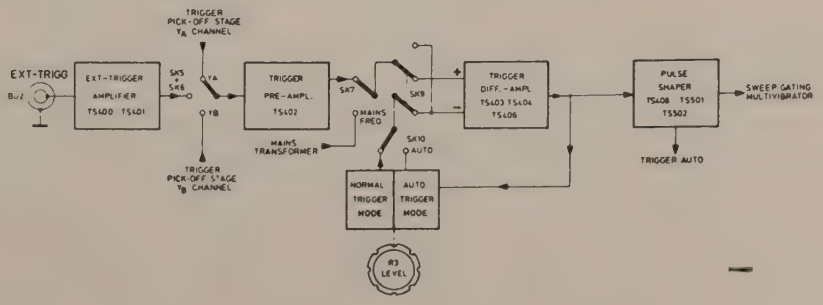


Fig. 3.3. Trigger unit

3.1.3.1. Trigger pre-amplifier for internal triggering

If Y_A push-button SK4 is depressed, trigger pick-off stage TS64 in the Y_A channel and transistor TS402 form together an amplifier with series and shunt feedback. Y_A push-button SK4 is only a mechanical release for Y_B push-button SK5 and is, therefore, not included in the circuit diagram; thus, SK4 depressed corresponds to SK5 released. The gain of trigger pre-amplifier is determined by the ratio of the shunt feedback resistance R412 and the series-feedback resistance in the emitter circuit of transistor TS64.

If Y_B push-button SK5 is depressed, trigger pick-off stage TS264 in the Y_B channel and transistor TS402 form the trigger pre-amplifier.

3.1.3.2. Trigger pre-amplifier for external triggering

If EXT. push-button SK6 is depressed, transistors TS401 and TS402 form together a similar amplifier with series- and shunt-feedback as described in section 3.1.3.1. Transistor 400 serves as an inverter for the triggering signals so that the next stage is driven in the correct phase. Moreover, this transistor improves the stability of the pre-amplifier. The external trigger input is protected against excessive positive input voltages by means of diodes GR401 and GR402.

3.1.3.3. Long-tailed pair circuit (differential amplifier)

The following description applies to internal triggering.
From the pre-amplifier the triggering signal is fed to the long-tailed pair circuit with transistors TS403 and TS404. The signal is applied to the base of transistor TS403 if + push-button SK8 is depressed and to the base of TS404 if – push-button SK9 is depressed.
This allows triggering on either the positive or negative slope of the signal. The + push-button SK8 is a mechanical release for – button SK9 and is, therefore, not included in the circuit diagram.

3.1.3.4. Trigger mode selector

A d.c. voltage which is variable with LEVEL potentiometer R3' is applied to the base of the non-driven transistor of the long-tailed pair circuit (3.1.3.3.).
As a long-tailed pair circuit amplifies the difference of the base voltages, the setting of potentiometer R3' determines which part of the signal will be amplified and, thus, the trigger level.
The output signal of the long-tailed pair circuit is fed to emitter follower TS406. If AUTO push-button SK10 is depressed, the a.c. component of the emitter signal of TS406 is applied to the full-wave rectifier with diodes GR404 and GR406. The rectified voltage across LEVEL potentiometer R3'' corresponds to the peak-to-peak value of the a.c. component of the trigger signal. This d.c. voltage is fed to the base of transistor TS404 of the long-tailed pair circuit. The result is that in the auto mode the trigger level range corresponds to the peak-to-peak value of the triggering signal.

3.1.3.5. Trigger-pulse shaper

The trigger-pulse shaper comprises transistors TS501 & TS502 in Schmitt-trigger configuration. With a repetitive trigger signal, a square-wave voltage of constant amplitude and width arises at the collector of TS502. This square-wave voltage is differentiated by C502 and R514 into narrow positive and negative pulses. The positive pulses are short-circuited by GR501 so that sweep-gating multivibrator TS503-TS504 receives only negative pulses.

3.1.4. TIME-BASE GENERATOR

The time-base generator comprises a sweep-gating multivibrator, a sawtooth generator, a hold-off circuit and an auto circuit.

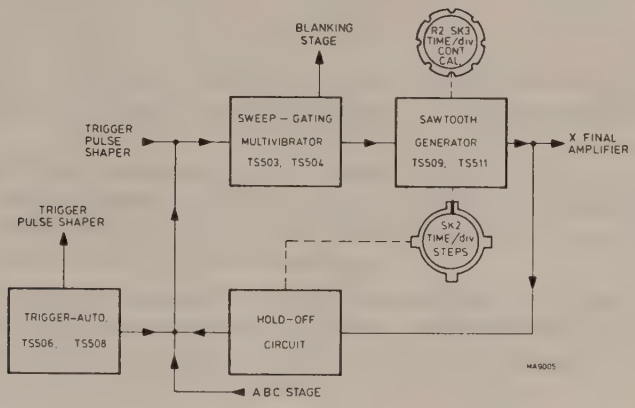


Fig. 3.4. Time-base generator

3.1.4.1. Sweep-gating multivibrator and sawtooth generator, single and erase functions

The sweep-gating multivibrator comprises transistors TS503 and TS504 in Schmitt-trigger configuration. In the state transistor TS503 cut off and transistor TS504 conducting, transistor TS509 is cut off. Then the time-base capacitor selected with TIME/div switch SK2 is charged with a constant current supplied by transistor TS511. The rate of voltage increases which determines the sweep time or time coefficient, is inversly proportional to the capacitance of the selected capacitor and direct proportional to the current through transistor TS511. This current is determined by the base voltage of transistor TS511, the voltage of which can be set by the TIME/div vernier control R2 and preset by potentiometers R534 and R539. The charging current is, moreover, determined by the value of the emitter resistors of transistor TS511, which are also switched over by TIME/div switch SK2.
The sawtooth voltage is taken off by a cascade circuit consisting of emitter followers TS512 and TS513 and applied to both the hold-off circuit and the horizontal amplifier.

Via the hold-off circuit, the sawtooth voltage is fed back to the input of the sweep-gating multivibrator whose input level is preset with stability potentiometer R553. At a certain value of the sawtooth voltage, in the automatic mode, the sweep-gating multivibrator is set to the state transistor TS503 conducting and transistor TS504 cut off. In the other trigger modes (except SINGLE mode) the switching over occurs when the sum of sawtooth voltage and trigger pulses reaches a certain value. Then transistor TS509 starts conducting and the time-base capacitor is discharged via this transistor. This cycle is repeated upon arrival of the next trigger pulse.

In the SINGLE mode a signal coming from flip-flop I.C. 1003 is fed to the input of the sweep-gating multivibrator via diode GR1026. The sum signal has such a level that incoming trigger pulses cannot switch over the multivibrator. Transistor TS503 is in the conducting state, transistor TS504 is cut off and transistor TS509 is conducting
By pressing the RESET button, the sum signal decreases to such a level that the first coming trigger pulse switches over the sweep-gating multivibrator and the sweep runs only once (see Fig. 3.12Simplified circuit diagram).

If the ERASE button has been pressed a signal is fed to the sweep-gating multivibrator via diode GR1027. This signal comprises a d.c. component and a pulse of 0,6 sec. which ensures that the time-base does not start again before the time-base capacitors have been entirely discharged. Due to this signal the sweep-gating multivibrator will be set to the state transistor TS503 conducting, transistor TS504 cut-off and transistor TS509 is conducting. In this position the time-base capacitors are discharged, and the time-base will run again upon arrival of the next trigger pulse (see Fig. 3.12. Simplified circuit diagram).

3.1.4.2. Hold-off circuit

Due to the effect of diode GR504, the charge of the hold-off capacitor selected with TIME/cm switch SK2, cannot follow the decay of the sawtooth voltage.
The capacitor voltage will then decrease with an RC time which is sufficiently large to allow the sawtooth to reach its zero level and to ensure the decay of the switching phenomena. During this RC time, the input level of the sweep-gating multivibrator is so high that incoming trigger pulses have no effect.

3.1.4.3. Auto circuit

The AUTO circuit makes the time-base generator free-running when there are no trigger pulses.
The AUTO circuit works in every trigger mode, except when either AC push-button SK11 or DC push-button SK12 is depressed.

If there are trigger pulses, they are fed to the base of transistor TS506 of the AUTO circuit. As a result of this, the two transistors TS506 and TS508 of the AUTO circuit are conductive until capacitor C506 is discharged. The voltage at the cathode of diode GR502 is then so positive that the latter remains blocked and the working of the sawtooth generator, as described above, is not affected.

As soon as there are no trigger pulses, capacitor C506 will be charged and diode GR502 becomes conductive. The voltage level at the input of the sweep-gating multivibrator TS503-TS504 then drops to such a value that the multivibrator switches over and a sawtooth is formed. This occurs immediately after the drop of the hold-off pulse, i.e., the time-generator is free-running.

3.1.5. HORIZONTAL AMPLIFIER

In the time positions of TIME/div switch SK2 the sawtooth voltage of the time-base generator is fed to the base of transistor TS603. The sawtooth is also applied, for external purposes, to TB OUT socket BU6 via emitter follower TS516.

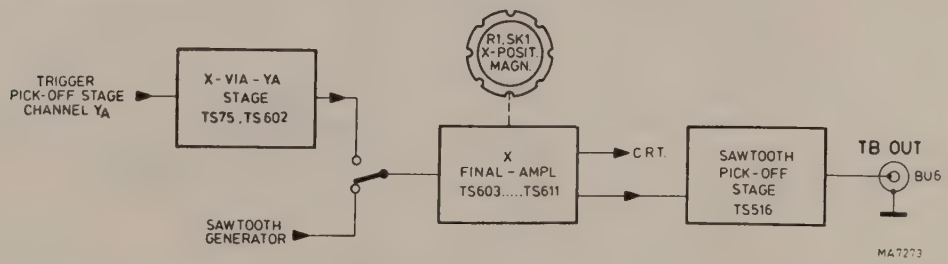


Fig. 3.5. Horizontal amplifier

In position X via Y_A of TIME/div switch SK2, the external X deflection voltage applied to the Y_A channel is fed from transistor TS64 to the base of transistor TS603, via emitter follower TS75 and amplifier TS602.
The external X deflection voltage is also applied to TB OUT socket BU6, via emitter follower TS516.

The horizontal output amplifier comprises two stages.
The first one with transistors TS603 and TS604 is provided with series-feedback.
The second one consists of two single-ended push-pull sections TS607-608 and TS609-611 with shunt-feedback.
From the latter stage the deflection signal is fed to the c.r.t.

The gain of the output amplifier is determined by the shunt-feedback resistors R628 and R633, and the emitter resistance of transistors TS603 and TS604.
X MAGN switch SK1 allows a gain control in two steps.
If switch SK1 is closed (X MAGN knob pulled out), the series-feedback in the emitter circuit of transistors TS603 and TS604 is decreased in such a way that the gain of the output amplifier is increased by a factor of 5.
In the latter mode, the magnified mode, the gain can be preset by means of potentiometer R617 and in the normal mode by means of potentiometer R618.
In position X via Y_A of TIME/div switch SK2, switch SK1 is bypassed and the output amplifier works in the magnified mode.

The horizontal shift voltage coming from X POSITION potentiometer R1 is supplied to the base of transistor TS604. Transistor TS606 acts as a constant emitter-current source for amplifier stage TS603-TS604.

3.1.6. CATHODE-RAY TUBE CIRCUITRY

3.1.6.1. General information

The CRT circuitry provides the voltage levels, timing pulses and comprises control circuits necessary for storage operation of the cathode-ray tube.

This circuitry consists of the following sections:

- Control circuits for correction and adjusting of astigmatism, trace rotation, orthogonality, flood gun voltages, barrel and pin-cushion distortion and focus.
- Storage unit.
- Automatic brightness control unit.
- Blanking circuit.

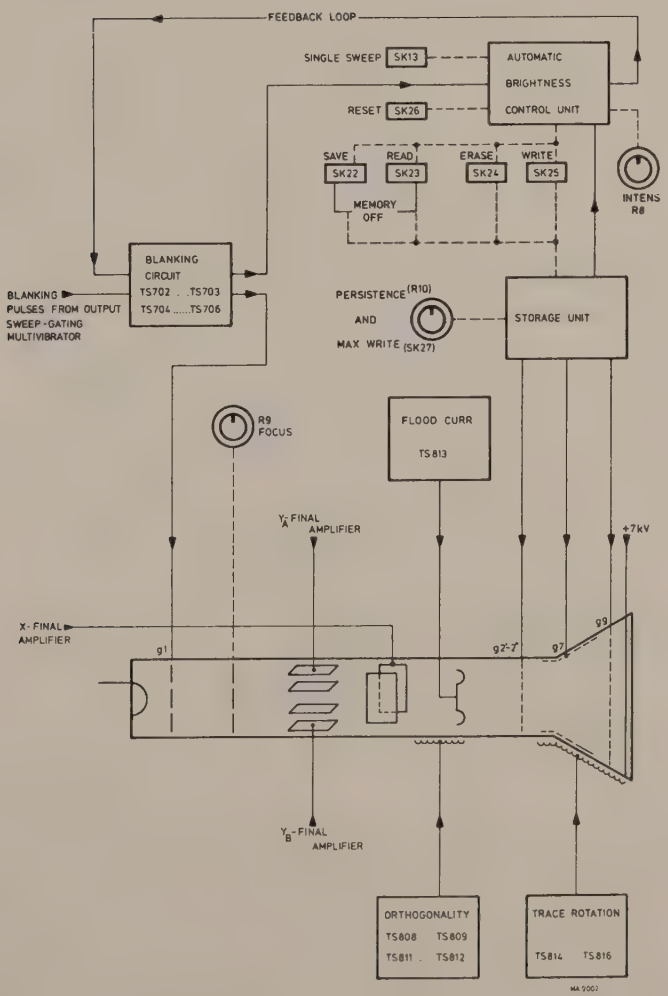


Fig. 3.6. Cathode-ray tube circuitry

3.1.6.2. Control circuits

. Astigmatism is corrected on a low-impedance level by means of potentiometer R809 via emitter follower TS801.

. Trace rotation is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan.
The degree and direction of rotation is determined by setting of potentiometer R813 on the bases of the complementary transistors TS814 and TS816.

. Orthogonality correction is also achieved by means of a coil, which is mounted inside the mu-metal screen. The magnetic field of this coil provides adjustment of the X/Y deflection angle to 90°. The current through this coil is controlled by two complementary pairs of emitter followers (TS808, TS809 and TS811, TS812), the base voltages of which are controlled by potentiometers R834 and R838.

. Flood gun cathode and grid (g1) voltages are controlled on a low-impedance level by emitter follower TS813. By means of potentiometer R847 the balance of both cathode voltages is adjustable. The flood current is controlled by the voltage levels on the grids "g1" and adjustable with potentiometers R848 and R849.

. Barrel and pin-cushion distortion is corrected with the aid of potentiometer R812.

. The display can be focussed by means of FOCUS potentiometer R9. In a spit-beam c.r.t. as used in this oscilloscope, focussing has certain consequences. These consequences and their remedies are discussed in section 3.1.6.2.1.

3.1.6.2.1. Focussing in the split-beam c.r.t.

In the split-beam c.r.t. the electron beam is split into two parts which form the traces of the Y_A and Y_B channel.
Both traces are controlled independently by the controls of both channels. The electron beam is focused, however, before it is split and, therefore, there is only one focus control. This mono-knob control of the focus has the following consequence.
Assume a focus setting as illustrated in Fig. 3.7.a.
Then the focusing point is exactly on the screen.
When the FOCUS potentiometer R9 is rotated, the focusing point is displaced to a point either side of the screen (Figs. 3.7.b. & 3.7.c.). This results in both traces moving away from each other. The more clockwise or anti-clockwise the FOCUS control is turned, the further the traces move apart.

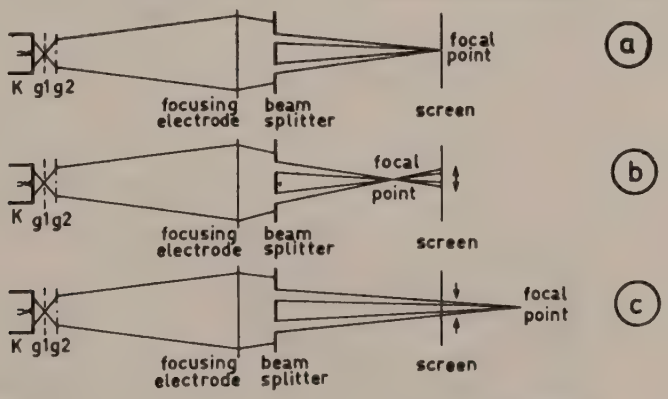


Fig. 3.7. Effect of the focus control

To compensate for this trace shift, an extra shift voltage is fed to the vertical amplifier channels via transistor TS56. The magnitude of this voltage is controlled by potentiometer R9' which is part of FOCUS tandem potentiometer R9. The control is such, that the displacement caused by operation of the FOCUS control is compensated for.
The compensation voltage for channel Y_A is obtained from the emitter of transistor TS56 and that for channel Y_B from the collector.
The compensation is so effective that the maximum displacement of each trace, caused by rotating FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise, does not exceed 2 mm.

3.1.6.3. Storage unit

3.1.6.3.1. General information

The storage circuit, located on the storage unit, supplies voltage levels and timing pulses to control the storage part of the C.R.T. in the SAVE, READ, ERASE and WRITE modes and in the positions PERSISTENCE and MAX. WRITE.
The storage circuit will be discussed with the aid of the simplified diagram of this circuit as shown in Fig. 3.12.
The schematic of this circuit is on the diagram Fig. 3.51. at the rear of the manual.

3.1.6.4. WRITE mode

The WRITE mode is operative after depressing push-button SK25.
Assume that as a result of an ERASE control signal the storage layer (g9) is at a potential below the cut-off level (Fig. 2.9. and 3.10.) and no flood-gun electrons reach the screen. We now activate the writing gun and let the electron beam move over the storage layer surface. Due to the high potential difference between the writing cathode and the storage mesh (approx. 1500 V), the electrons arrive at the storage layer with such an energy (velocity) that secundary emission occurs. Wherever the surface is struck by the electrons, a positive charge will arise. The highest potential that can be attained in this way is +32 V (see Fig. 3.9.) in relation to earth (approx. same potential as the flood gun cathode). At any value above this potential, the flood-gun electrons would be attracted by the storage-layer surface, thus reducing its potential to the original +32 V value. Those areas of the storage-layer surface that have been charged to near +32 V in relation to earth, allow the post-accelerator field to 'reach through' and capture flood-gun electrons.
Thus, the pattern of charge on the storage-layer surface is displayed on the screen.

In the WRITE mode, potentiometer PERSISTENCE may be used to vary display persistence from less than 0,3 sec to more than 1,5 min. This persistence control is attained by using a series of square-wave pulses (Fig. 3.10.) in order to periodically "wipe" the written signal from the storage layer.
These erasure pulses are obtained by comparing (I.C. 1001 4.5.13.) a 2 kHz triangular voltage with the variable d.c. voltage of PERSISTENCE potentiometer R10.
For explanation of the diagrams are 3.1.6.7. "Erasure in the write mode".

The potential of the flood-gun accelerators g'2 and g"2 depends on the selected operating mode (see Fig. 3.8. and oscillogram 19 in the circuit diagram). In the MEMORY OFF (SAVE and READ push-buttons operated simultaneously) and WRITE modes, transistor TS1019 is hard on and the potential of the flood-gun accelerators is continuously +80 V in relation to earth.

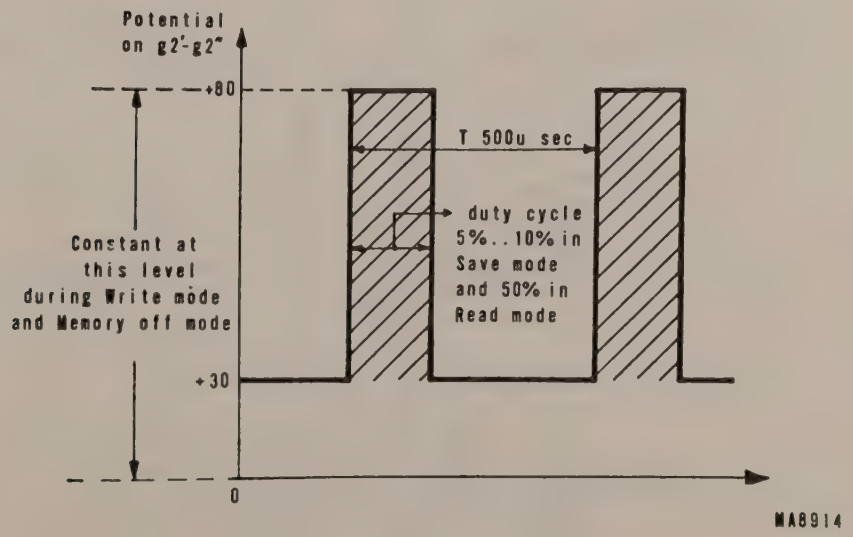


Fig. 3.8. Flood gun accelerators potential during storage mode

3.1.6.5. SAVE and READ modes

If either the SAVE push-button or the READ push-button is depressed, the flood-gun accelerators are supplied with a positively pulsed signal at different duty cycles (see Fig. 3.8.) which determines the display brightness. This pulse signal is obtained by comparing the 2 kHz triangular voltage with fixed (via R1064 and R1067) or variable (via R1068) d.c. voltages. When the READ push-button has been depressed, the duty cycle is 50 %. If push-button SAVE is depressed, the duty cycle is 5 to 10 % (value adjusted by means of preset potentiometer R1068). In this mode, as the duty cycle is low, the flood current will be minimum. Due to this, the brightness is low, and the storage time will be maximum.

3.1.6.6. ERASE function

The stored information can be erased in two different ways:
either manually or automatically. Automatic erasure is possible in the WRITE mode only, the duty cycle being dictated by the setting of the PERSISTENCE potentiometer.

Manual erasure

In the manual erasure mode the potential of the storage mesh (g9) is varied in accordance with the curve shown in Fig. 3.9.a.
The corresponding curve for the storage-layer surface potential is shown in Fig. 3.9.b.
If the ERASE push-button is operated during the period t0-t1, the potential of the storage mesh is equalised to that of the collector mesh (+180 V).

Owing to the capacitive coupling, the storage-layer surface potential rises to almost the same value. As Va is then +180 V in relation to earth, the storage-layer surface is bombarded with flood-electrons of much higher energy level than at first cross-over point (see Fig. 2.4.), which results in a large amount of secundary emission. Therefore, the surface potential becomes strongly positive (+180 V) and all information in the storage layer is overruled. The surface potential cannot increase much beyond +180 V because the collector mesh would then repel the emitted electrons back to the storage surface, tending to decrease its potential.

If the ERASE button is released at moment t1, the potential of the storage mesh drops to +32 V (due to the pulses produced by the circuits "time delay" and the logic circuit I.C. 1002) and the storage layer surface follows suit due to the capacitive coupling.
After 200 ms at moment t2, the storage mesh potential is automatically raised to +38 V in relation to earth. It is held at this value for 400 ms. The storage-layer surface is raised to the same potential due to the capacitive coupling, but then starts capturing flood-gun electrons and the potential decays again towards +32 V in relation to earth.

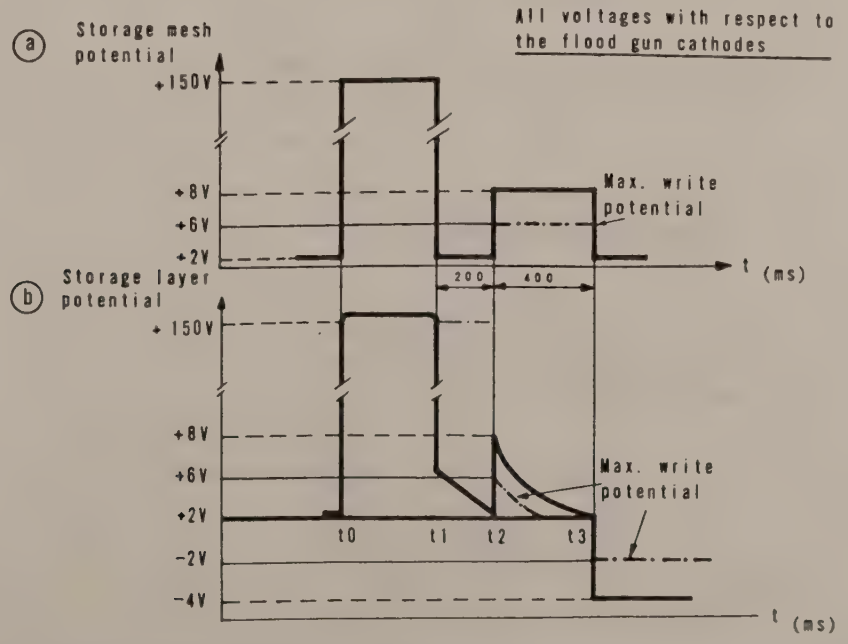


Fig. 3.9. a. Storage-mesh potential during erase cycle
b. Storage-layer surface potential during erase cycle

At the end of the 400 ms at moment t3, the storage mesh potential drops to +32 V. As a result, the potential of the storage-layer surface drops from +32 V to +26 V. The erasure cycle is then complete and the system is in waiting position. During the erasure cycle, there is fed via diode GR1027 a d.c. signal to the hold-off circuit to inhibit initiation of a sweep during erasure. After releasing push-button ERASE a delayed signal of 0,6 sec + 0,3 sec , extra delay via C1029 - R1110 (via the same diode) ensures the decay of the charge of the time base capacitors to zero level.

3.1.6.7. Erasure in the WRITE mode

In the WRITE mode, the potential of the storage-layer surface is gradually brought back to below the cut-off value by a number of automatic cycles of pulsed erasure (see Fig. 3.10.a.). The erasure signal is a square-wave voltage of approximately 2 kHz supplied by IC1001 and fed to storage mesh g9. This signal and the appertaining potential on the storage-layer surface are shown in Fig. 3.10. (b & c).

As in the manual erasure mode, the storage layer potential follows the voltage changes on the storage mesh. However, during each pulse the storage layer potential becomes positive in relation to the flood-gun electrons. Consequently, the potential drops by an amount of ΔV (see Fig. 3.10.b.). If this process is repeated a number of times, the rest potential on the storage-layer surface will eventually pass the cut-off level and the stored information will be erased. When the pulse width or, in other words, the duty cycle is increased, the drop in layer potential is increased too ($\Delta V'$ in Fig. 3.10.c.) and it takes less time (or pulses) to complete the erasure. The duty cycle of the erasure pulses can be varied between 0 and 30 % (corresponding to 0.3 seconds and 1.5 minutes) by means of PERSISTENCE potentiometer R10.

3.1.6.8. MAX. WRITE mode

The secundary emission of electrons from the storage-layer surface caused by the bombarding flood-gun electrodes must charge the layer from its erased potential of +26 V (all voltages in relation to earth) to the storage threshold (cut-off level) of approximately +29 V, before flood-gun electrons come under the influence of post accelerator g10 (see Fig. 3.9.&3.10.). Therefore, it is obvious that the writing speed of the c.r.t. can be enhanced by erasing the surface to just below the storage threshold, say to +28 V in stead of +26 V. If the instrument is switched to the MAX. WRITE mode, R1081 and R1083 are connected in parallel to R1082 and R1084. As a result of this, the amplitude of the erase pulse between moments t2 and t3 in Fig. 3.9.b. is approximately halved. Consequently, the potential of the storage-layer surface after erasure is approximately +28 V. As the layer potential is raised to almost the threshold potential, a larger part of the electron cloud will reach the phosphor viewing screen, resulting in a light-green background hue. Although the contrast is reduced a little, the writing speed for fast single shot signals is increased by a factor of 10.
In the MAX. WRITE mode, also the collimator voltage is adapted to the new circumstances by changing the current flow to the summation point of the OP-AMP. This results then in a lower collimator voltage. The erasure signal is always fed to the collimator in order to shake the electron cloud. In this way, an even hue is obtained.

The output quantity of the ΔV collimator device, the collimator voltage level device and the max. write device are combined in operational amplifier TS1014-TS1015. This operational amplifier is basically the adding circuit shown in figure 3.11.

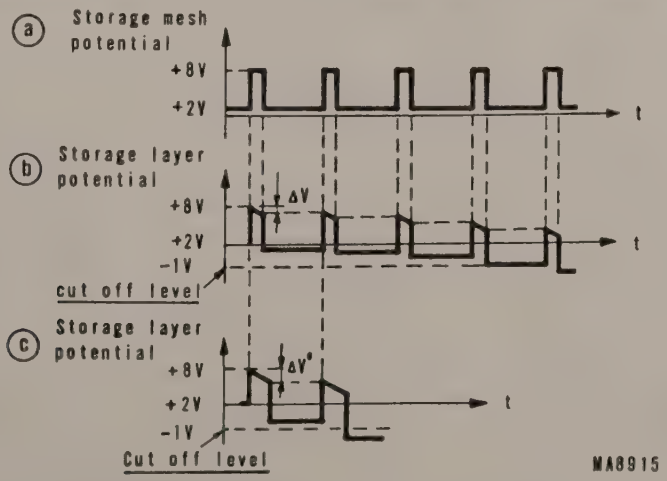


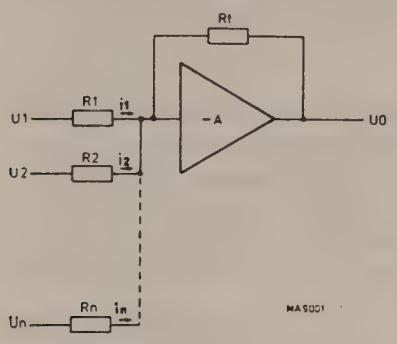
Fig. 3.10. a. Storage-mesh potential during variable persistence mode
b. Corresponding storage-layer surface potential containing information
c. Same as b. but persistence adjustment shorter (bigger pulse width)

3.1.6.9. Automatic brightness control unit

The A.B.C. unit is a circuit which controls the trace brilliance by means of the following devices.

- The ratio between sweep time and combination sweep time/hold-off time (in the following text this ratio will be called duty cycle). If this ratio drops to half, i.e. half the sweep time at the same combination time, the trace brilliance will double so as to give a constant brilliance impression on the screen.
- The INTENS potentiometer which operates on a low voltage level.
- During erasure, the beam must be suppressed. In the display mode y = f(t), the trace is blanked by a signal from the time-base generator. In the display mode y = f(x), blanking is provided by a special circuit.

The output quantities of the devices are combined in operational amplifier TS1029-TS1031. This operational amplifier is basically the adding circuit shown in Fig. 3.11.



Relation between input and output quantities in an adding circuit is:

$U_o = R_t (i_1 + i_2 + ... i_n)$

$$U_o = R_t \left(\frac{U_1}{R_1} + \frac{U_2}{R_2} + ... \frac{U_n}{R_n} \right)$$

Fig. 3.11. Operational amplifier

The output voltage of this operational amplifier is used as supply voltage for the Z amplifier (collector voltage of TS704).

Blanking circuit and duty cycle

The blanking circuit blanks the c.r.t. during the fly-back of the time-base generator and unblanks the c.r.t. during the sweep and constantly if TIME/cm switch SK2 occupies position X via Y_A.

The blanking circuit operates on a low voltage level and comprises an a.c. and a d.c. path.

Transistor TS706 is driven by the collector signal of transistor TS504 in the sweep-gating multivibrator. Transistor TS706 forms together with transistor TS704 a single-ended push-pull circuit. The gain factor of this amplifier is such that even when the collector voltage of TS704 is maximum, the Z signal is limited to this voltage. In other words, the amplitude of the Z signal is determined by the output voltage of operational amplifier TS1029-TS1031.

- A.C. PATH : The amplified a.c. components of the blanking signal are fed direct to the Wehnelt cylinder of the c.r.t. via H.T. capacitor C707.
- D.C. PATH : For the d.c. component of the blanking signal, the signal of oscillator TS702-TS703 is used. The oscillator signal is modulated with the blanking signal. The amplified modulated signal on the collector of transistor TS703 is via capacitor C706 fed to demodulator GR702-R713. After demodulation, also the d.c. component of the blanking signal is available.

The a.c. and d.c. amplifications are equalized by means of potentiometer R711.
The Z signal (diagram 11 of Fig. 3.51) is fed via a divider/integrator circuit to the emitter follower TS1028. Via emitter follower TS1028, this signal is applied to input of operational amplifier TS1029-TS1031. In this way, a closed loop is obtained. The other output quantities of the a.b.c. unit are also used as input signals for this loop. In the loop, the mean value of the Z signal is fed back to the blanking stage with transistors TS702, 703, 704 and 706. If the loop gain were very large, the mean value would be constant owing to the feedback. A constant mean value means: half the amplitude when the pulse width is doubled.

The loop gain, however, is low (≈ 4) and, therefore, the duty cycle is not inversely proportional to the amplitude of the Z signal. The relationship between the Z signal on the Wehnelt cylinder and the beam current (intensity) to the screen of the c.r.t. is not linear either, because of the curved c.r.t. characteristic. Both types of non-ideal behaviour together result, however, in an inversely proportional relationship between beam current and duty cycle.

In the lower sweep speed positions of the time-base generator, the period time of the Z signal is long. To be able to integrate these signals well the time constant of the integrator must be large, i.e. several seconds. There is also the requirement that the system must be able to react fairly quickly: well within one second, in the faster sweep speed positions. Both requirements are incompatible. Therefore, a small time constant is used in this oscilloscope, whereas in the slower sweep-speed positions (20 mS - 0,5 S) capacitor C1027 is interrupted. As a result of this the output of the blanking stage will not be integrated in these slower sweep-speed positions.

Blanking and unblanking in WRITE, READ, SAVE and MEMORY-OFF mode

The four functions WRITE, READ, SAVE and MEMORY-OFF are selected by means of switches SK22, SK23 and SK25. The Z signal must only be present in positions MEMORY-OFF and WRITE. In the two latter positions a switch in series with resistor R1116 is interrupted. The current flowing through R1116 to the summation point then becomes zero. As a result of this, output voltage U_o of operational amplifier TS1029-TS1031 is able to raise and the Z signal is not zero any longer.

Blanking in the erase mode

In position X via Y_A of switch SK2, the y = f(x) mode, a logic '1' is applied to input 12 of NAND IC1003, via R1107 and GR1028. If at the same time a logic '1' is applied to the other input, point 13 of IC1003, via ERASE switch SK24, the logic output on 11-IC1003 will be '0'. Then R1114 is connected to +20 V and a current flows to the summation point of operational amplifier TS1029-TS1031. The output voltage U_o of the operational amplifier then drops to such a value that the Z signal becomes zero.

In the other positions of SK2, one of the inputs of IC1003 is always logic '0' regardless the level on the other input. The output on point 11 is then always '1', switch TS1023 is opened and no current flows through resistor R1114.

Intens potentiometer

The magnitude of the Z signal may be varied by changing the current to the input of operational amplifier TS1029-TS1031. Continuous control of the brightness is obtained by varying the current through R1137 with the aid of potentiometer R8. With preset potentiometer R1138, the maximum brightness is set.

3.1.7. POWER SUPPLY

The power supply comprises the mains transformer, a full-wave rectifier, stabilized power supply and converter.

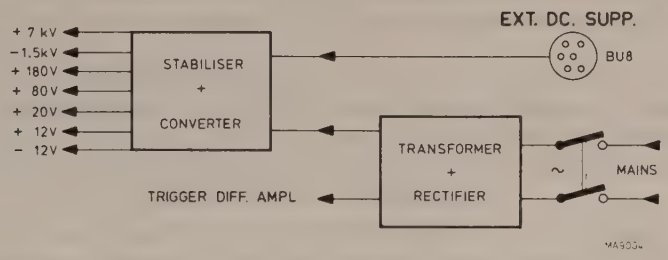


Fig. 3.13. Power supply

3.1.7.1. Mains transformer

Mains transformer TS801 has three primary windings (S1, S1' and S1'') which, together with the secondary winding (S2), can be combined by means of voltage adapter SK21. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

The voltage on secondary winding is full-wave rectified. The resulting negative d.c. voltage, or alternatively a negative d.c. voltage on EXT DC SUPPLY input socket BU8, is applied to the voltage stabilizer and converter.

Part of the a.c. voltage on secondary winding of the mains transformer is fed to MAINS trigger source switch SK7, to enable internal triggering on the mains frequency.

3.1.7.2. Converter and stabilized power supply

The converter is a regenerative square-wave generator operating at a frequency of approx. 18 kHz.
A basic diagram of the converter is shown in Fig. 3.14.

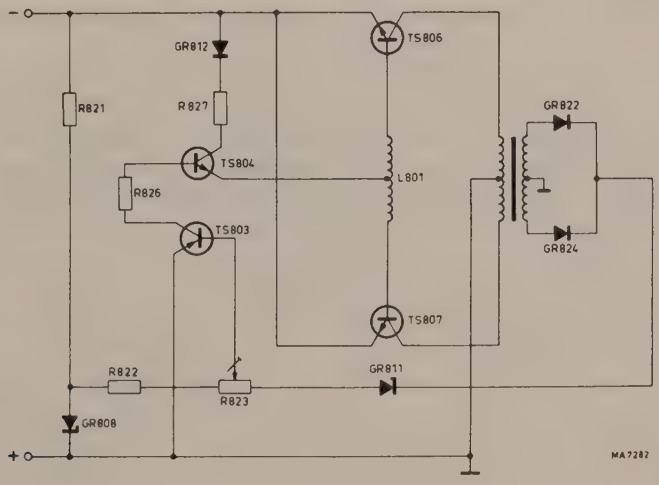


Fig. 3.14. Basic diagram of the converter

In the converter, transistors TS806 and TS807 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of L801/802. Assume that transistor TS806 has a slightly higher current gain than TS807. Then the positive voltage from the feedback winding quickly drives transistor TS806 into saturation. The current in the top half of the primary of L801/802 increases linearly at a rate determined by the inductance in the primary. This current increase continues until the iron in transformer coil L801 is saturated.
Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feedback winding. When its base drive ceases, transistor is cut off. This reverses the polarity of the feedback voltage and transistor TS807 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction. The subsequent absence of feedback voltage initiates the switching back to TS806 and the cycle starts again.

The regulation works as follows. When an input voltage is applied to the converter, the negative voltage across Zener diode GR808 turns transistor TS803 fully on, as there is no positive voltage from Zener diode GR811.

Then a bias current starts flowing from earth via transistor TS803 through resistor R826, through the base-emitter junction of transistor TS804 (operating as a diode since diode GR812 interrupts the collector circuit) and from base to emitter of both transistors TS806 and TS807.
As there is then an a.c. voltage across the secondary of L801/802, diodes GR822 and GR824 produce a positive d.c. voltage. This voltage reduces the current through transistors TS803 and TS804 sufficiently to limit the drive to transistors TS806 and TS807 and produce the desired output level. The setting of potentiometer R823 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via Zener diode GR811 to transistor TS803 so that the drive of transistors TS806 and TS807 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.

After rectifying the secondary voltages +12 V (reference), −12 V, +20 V, +80 V, +180 V, −1500 V and high voltage +7000 V are obtained. The voltage quadrupler which supplies the +7000 V cannot be repaired and must be replaced when it breaks down.

All supply voltage except the +7000 V and the −1500 V can be continuously short-circuited without damage to the components. Resistor R827 limits the maximum base current drive to transistors TS806 and TS807 and thus the maximum power output which can be drawn from the converter.
Resistor R826 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors TS806 and TS807 at a safe level. Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp failing to light up.

3.1.8. CALIBRATION VOLTAGE

The calibration voltage generator consists of free-running multivibrator TS750 & TS751. The generator frequency is approximately 2 kHz. The amplitude of the generated square-wave voltage is kept at a constant value by means of zener diode GR751. The exact value of the calibration is set with the aid of potentiometer R761.

3.2. Checking and adjusting

3.2.1. GENERAL INFORMATION

All adjusting elements have been listed in the heading of the various sections.
The tolerances mentioned in the following text apply to newly adjusted instruments only. The values may differ from those given in chapter 1.2. CHARACTERISTICS.
Unless otherwise stated the controls always occupy the same position as the previous check.

3.2.2. POWER SUPPLY

3.2.2.1. Mains current

- Check that the mains voltage adapter (SK21) has been set to 220 V and connect the instrument to such a voltage (frequency 50 Hz)
- Switch the oscilloscope on and check that the pilot lamp lights up
- Check that the current consumption does not exceed 300 mA (measured with a moving-iron meter)

3.2.2.2. Supply voltages (R823)

- Check that the voltage across capacitor C833 is +12 V, + or −20 mV; if necessary, readjust potentiometer R823 (Fig. 3.15.).
- Check the supply voltages in accordance with the following table:

Voltage across	Required value	Max. allowable ripple
C833 (Fig. 3.15)	+ 12 V, ± 30 mV	4 mV_{p-p}
C836 (Fig. 3.15)	− 12 V, ±400 mV	6 mV_{p-p}
C831 (Fig. 3.15)	+ 20 V, ±900 mV	40 mV_{p-p}
C829 (Fig. 3.15)	+ 80 V, ± 2 V	250 mV_{p-p}
C828 (Fig. 3.15)	+180 V, ± 3 V	100 mV_{p-p}

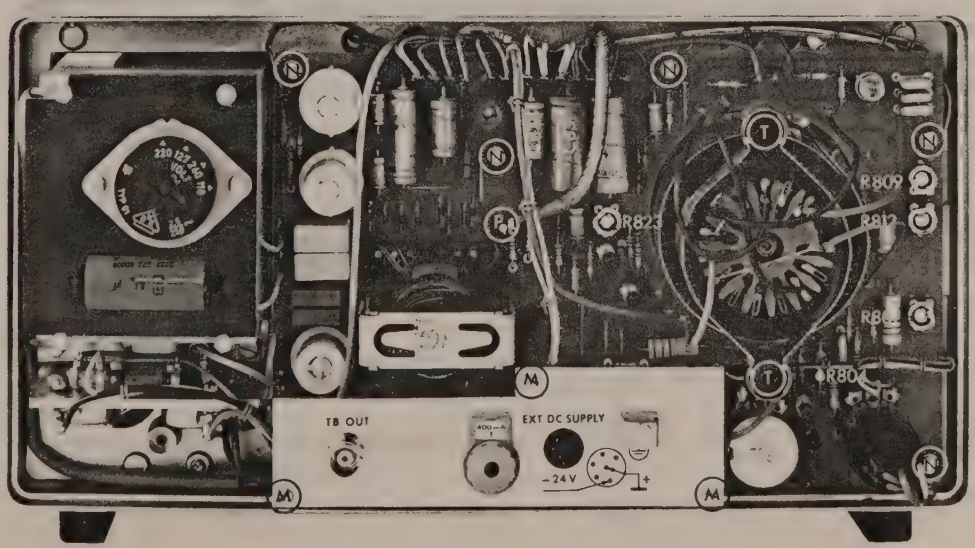


Fig. 3.15. Adjusting and dismantling

- Vary the a.c. voltage to which the instrument is connected between 198 V and 242 V.
- Check that the supply voltages do not vary more than 0.5 % and that the ripple voltages do not exceed the values mentioned in the table above.

3.2.3.1. Adjustment to display time-base lines

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display. Extended high intensity may damage the C.R.T.

3.2.3.1.1. Intensity (R801) and time-base stability (R553)

– Turn INTENS potentiometer R8 anti-clockwise.

1500 V: Use an insulated screw-driver

– Set potentiometer R801 (Fig. 3.15.) to its mid-position and potentiometer R553 (Fig. 3.17.) anti-clockwise.
– Depress buttons SAVE SK22 and READ SK23 simultaneously.
– Set X POSITION potentiometer R1 to its mid-position and depress MAGN switch SK1.
– Set the POSITION potentiometers R11 and R12 to their mid-positions.
– Set TIME/div switch SK2 to 1 ms.
– Depress BEAM SELECTOR switches A SK14 and B SK15.
– Set AMPL switch SK17 and SK18 to .2 V/div.
– Turn INTENS potentiometer R8 for a well-defined display, there should be a display of two time-base lines.
– If both traces are not equally bright, see point 3.2.3.2. "Beam correction".
– See for adjusting with component R801 point 3.2.3.6.

3.2.3.1.2. Time-base stability (R553)

– Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
– Turn potentiometer R553 (Fig. 3.17.) clockwise until the time-base line disappears.
– Depress AUTO switch SK10. A time-base line must become visible. If necessary, readjust potentiometer R553.

3.2.3.2. Beam correction (with the magnets)

– Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
– Set TIME/div. switch SK2 to 1 mS.
– Position the traces symmetrically around the centre of the screen using POSITION potentiometers R11 and R12.
– Set AMPL switch SK17 and SK18 to 0,2 V/div.
– Adjust INTENS potentiometer R8 for a low brightness.
– Check that both traces are equally bright. If necessary, turn screw T (Fig. 2.1) until both traces have the same brightness.

3.2.3.3. Focus and astigmatism (R809, R804)

– Set the TIME/div. switch to position X via Y_A.
– Position the spot to the centre of the screen using potentiometers X POSITION R1 and Y POSITION R12.
– Set INTENS potentiometer R8 for a just visible spot.

Use an insulated screw-driver

– Adjust FOCUS potentiometer R9 and astigmatism potentiometer R809 (Fig. 3.15.) for a sharp, well-defined spot.
– Set FOCUS potentiometer R9 in mid-stroke position and check for a sharp spot. If necessary select a different value for R804 (Fig. 3.15.).

3.2.3.4. Trace rotation and orthogonality (R813, R834, R838)

- Depress WRITE button SK25.
- Turn the PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Depress BEAM SELECTOR switch B SK15.
- Set INTENS potentiometer R8 for a low brightness.
- Push ERASE button SK24.
- Set TIME/div switch SK2 to X via Y_a.
- Set AMPL switches SK17 and SK18 to .2 V/div and AMPL potentiometer R4 and R5 to CAL.
- Apply a sine-wave signal of 1 kHz with amplitude of 4 V to inputs Y_A (BU3) and Y_B (BU5).
- Set AC-0-DC switch SK16 to AC.
- Set AC-0-DC switch SK19 to 0.
- Centre the time-base line by means of POSITION potentiometer R12.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust trace rotation potentiometer R813 (Fig. 3.16.).
- Set AC-0-DC switch SK16 to 0.
- Set AC-0-DC switch SK19 to AC.
- Centre the displayed line by means of X-POSITION potentiometer R1.
- Check that the displayed line runs exactly in parallel with the vertical lines of the graticule. If necessary, readjust orthogonality potentiometer R834 or R838 (Fig. 3.16.).

3.2.3.5. Barrel & pin cushion distortion (R812)

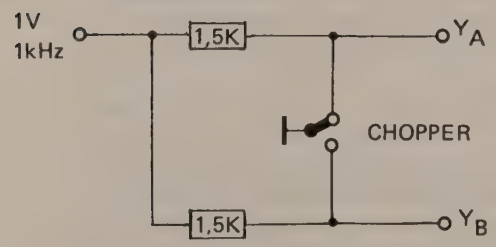
- Shift with the aid of X-POSITION potentiometer R1 the displayed vertical line (see point 3.2.3.4.) to the left- and right-hand side of the screen.

  Use an insulated screw-driver. Be careful not to make any short-circuits.

- Check that the displayed line is straight and vertical in both positions.
  A small deviation may occur. If necessary, adjust and determine an average setting with the aid of potentiometer R812 (Fig. 3.15.).
- For optimum adjustment, repeat both checks 3.2.3.4. and 3.2.3.5.
- Set TIME/div switch SK2 to 2 μs/div.
- Shift with POSITION potentiometer R11 the displayed horizontal line to the upper and lower side of the screen.
- Check that the displayed line is straight; adjustable with potentiometer R812.
  If this adjustment was necessary, repeat both procedures 3.2.3.4. and 3.2.3.5.

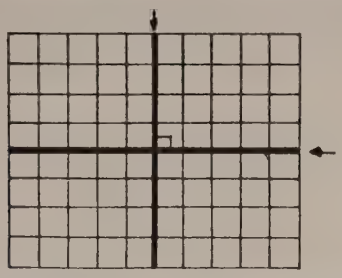
Trace rotation, orthogonality and Barrel & pin cushion distortion can also be adjusted in a different way:

- MEMORY OFF mode
- Channels A and B
- TIME/DIV to X via Y_A
- VOLT/DIV at 50 mV
- AC/0/DC to DC

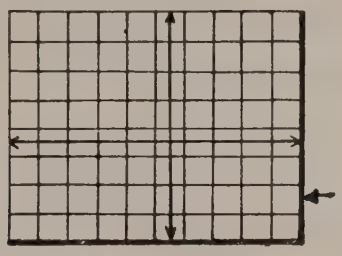


- Connect a channel-switch (see figure) to the input sockets.

– Centre both traces (using X-POSITION and Y-POSITION)
– Potmeter R838 to mid-range
– Align displayed lines with central vertical and horizontal graticule lines, using potmeters R813 and R834.



– Align the displayed lines with the outer graticule lines, using the X and Y POSITION potmeters.
– Straighten the displayed lines, using potmeters R812 and R813.



3.2.3.6. Brightness (R801, R711 and R1138)

<u>1500 V: Use an insulated screw-driver</u>

– Depress BEAM SELECTOR switches SK14 and SK15.
– Switch the instrument on at least 15 minutes before starting the next check.
– Set TIME/div. switch SK2 to X via Y_A.
– Set the INTENS potentiometer R8 to 90° from anti-clockwise stop
– Adjust potentiometer R801 (Fig. 3.15) for a barely visible spot (or just no display).
– Set TIME/div. switch SK2 to 10 mS/div.
– Set the INTENS potentiometer R8 to normal brightness.
– Shift the time-base lines on to the centre of the screen with the aid of POSITION potentiometers R11 and R12.
– Check that the time-base line shows a constant brightness over the entire length; if necessary, readjust potentiometer R711 (Fig. 3.17).
– Switch the instrument off, disconnect the flood gun Stocko connector and discharge G10.
– Depress both the SAVE (SK22) and READ (SK23) buttons (MEMORY OFF MODE).
– Set TIME/div. switch SK2 to X via Y_A and center the spot to the centre of the screen.
– Insert a μA meter, which is floating and good insulated, between G10 and the high tension unit (Fig. 3.19).
– Note the dark current: X μA.
– Set the INTENS potentiometer R8 fully clockwise.
– Adjust potentiometer R1138 (Fig. 3.17.) for a meter reading of 0,5 μA + X μA.
– Check that the meter reading lies between 0,8 and 1,2 μA in TIME/div. positions 0,5 S/div. to 0,2 μS/div. incl.
– **Switch the instrument off**, remove the μA meter, connect the floodgun Stocko connector and switch the instrument on again.

3.2.3.7. Focus correction

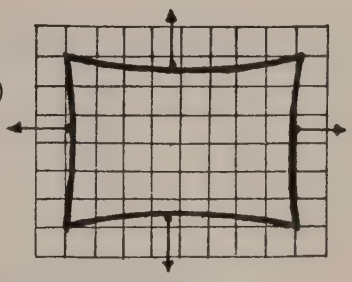
- Set TIME/div. switch SK2 to 0,5 mS/div.
- Depress buttons SAVE SK22 and READ SK23 simultaneously.
- Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
- Set AC-0-DC switches SK16 and SK19 to 0.
- Set the INTENS potentiometer R8 to low brightness.
- Set AMPL switches SK17 and SK18 to .5 V/div and AMPL potentiometers R4 and R5 to CAL.
- Shift the time-base lines on to the horizontal central graticule line with the aid of POSITION potentiometers R11 and R12.
- Rotate FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise and check that this does not cause the time-base lines to shift more than 0,2 div.

3.2.3.8. Flood-current (R844, R846, R847, R848, R849)

- Switch the instrument on at least 15 minutes before starting this check.
- Depress WRITE switch SK25.
- Set INTENS potentiometer R8 for minimum brightness.
- Set R847 (Fig. 3.19.) to its mid-position.
- Connect (floating) a DC mV-meter across R846 and adjust R848 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.
- Connect the mV-meter across R844 and adjust R849 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.

3.2.3.9. Backing-electrode G9 (R1059)

- Depress WRITE switch SK25.
- Adjust potentiometer INTENS R8 for minimum brightness.
- Rotate potentiometer PERSISTENCE R10 to its first clockwise stop.
- Connect a DC voltmeter Between G9 (+) and cathode K' (—). (Fig. 3.19.)
- Adjust R1059 (Fig. 3.19.) to obtain a 2 V (±100 mV) reading on the meter.



3.2.3.10. Collimator G7 (R1046)

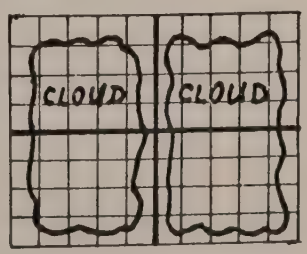
- Turn R10 PERSISTENCE entirely counter-clockwise.
- Push SK25 WRITE.
- Adjust R1046 (Fig. 3.19.) until the contour-distortions are just outside the measuring graticule.

3.2.3.11. Background just black (R847, R1044, R1084)

- Rotate potentiometer PERSISTENCE R10 to its first clockwise stop (not the MAX. WRITE mode)
- Turn potentiometer R1044 (Fig. 3.19.) to mid-range.
- Carry out the following adjustments on repetitive operation of the ERASE button SK24.
- Adjust R1084 (Fig. 3.19.) to obtain two barely visible clouds on the screen.
- Adjust R847 (Fig. 3.19.) for equal intensity of the clouds.
- Adjust R1084 (Fig. 3.19.) so, that the background of the screen is just black.

Max. Write (R1044, R1049 and R1083)

- Carry out the following adjustments on repetitive operation of the ERASE button SK24.
- Turn potentiometer PERSISTENCE R10 to its second clockwise stop (MAX. WRITE position).
- Set the potentiometers R1044 (Fig. 3.19.) and R1049 (Fig. 3.19.) to mid-range.
- Set potentiometer R1083 (Fig. 3.19.) entirely counter-clockwise.
- Two too bright clouds appear on the screen.
- Adjust potentiometer R1083 (Fig. 3.19.) for a uniform cloud distribution on the screen; to obtain sufficient contrast for the display, the background should not be too bright. If necessary, equalize the brightness of both clouds, using potentiometer R847 (Fig. 3.19.).
- Adjust potentiometer R1044 (fig. 3.19.) in such a way that both clouds reach as much screen surface as possible and obtain equal cloud distribution.



- Repeat above procedure, for optimum results, combined, if necessary, with writing-speed check dealt with in point 3.2.3.14.

3.2.3.12. Save (R1068)

- Depress SAVE switch SK22.
- The intensity of a saved signal is adjustable with R1068 (Fig. 3.19.).
- The normal position of R1068 is such that the square-wave voltage at G2' and G2'' shows 10 % duty cycle (±10 %).

3.2.3.13. Whistle (R1031)

- Turn potentiometer PERSISTENCE entirely anti-clockwise.
- It may happen that the meshes inside the CRT come into resonance with the square-wave voltages applied to them (about 2 kHz). This can be tuned out by a slight readjustment of R1031 (Fig. 3.19.).

3.2.3.14. Writing speed (writing and calculation)

Definition: The writing speed is the maximum speed of the electron in X- or Y-direction on the screen in single-shot mode at which the written line is visible.
The lines of the pictures obtained must be clearly visible in the WRITE mode as well as in MAX. WRITE mode.
Some divisions at the edge of the screen may be partly written or not at all (the written surface of the screen must be as symmetrical as possible).
The number of non-written divisions may not be more than 16 namely 20 % of the total 8x10=80 divisions of the measuring graticule.

Note: Before this check, the sensitivity of the vertical amplifiers must be adjusted (see point 3.2.4.5. SENSITIVITY).

- Set TIME/div switch SK2 to 2 ms/div and potentiometer TIME/div R2 to CAL.
- Turn INTENS potentiometer R8 entirely clockwise.
- Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Depress AUTO switch SK10.
- Depress WRITE switch SK25.
- Set AMPL switches SK17 and SK18 to 50 mV/div and AMPL potentiometers R4 and R5 to CAL.
- Apply a sine-wave signal of 1,6 $V_{p\text{-}p}$, 1 kHz, to Y_A input socket BU3 (a picture height of 32 divisions should be obtained).
- Set the POSITION potentiometers R11 and R12 to their mid-positions.
- Set AC-0-DC switches SK16 and SK19 to AC.
- Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
- Depress SINGLE switch SK13.
- Turn potentiometer PERSISTENCE R10 to its first clockwise stop.
- Push ERASE button SK24 shortly.
- Push RESET button SK26.
- The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.
- Apply the input voltage from the Y_A input socket BU3 to Y_B socket BU5.
- Depress Y_B switch SK5.
- Depress BEAM SELECTOR switch SK15, BEAM SELECTOR switch SK14 in released position.
- Push ERASE button SK24 shortly.
- Push RESET button SK26.
- The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.

– For both channels the focus has been adjusted for a maximum, and thus the maximum writing speed.
– Push ERASE button SK24 shortly.
– Push RESET button SK26.
– Check with the aid of a viewing hood that the display covers over 80 % of the measuring graticule.

For checking in MAX. WRITE mode the operation is the same but:
– Turn potentiometer PERSISTENCE R10 to its second clockwise stop.
– Frequency of the input signal 10 kHz.
– Set TIME/div switch SK2 to .2 ms/div.

Calculation: The vertical deflection is 32 divisions as mentioned above.
The path described by the electron beam is then 16 div. $\sin\omega t$ (ω being the circle frequency of the input signal).
The speed of the beam in the vertical direction is thus 16 $\omega\cos\omega t$ (the speed in horizontal direction is negligible).
For the visible part of the sine wave, $\cos\omega t = 1$ may be assumed.
The wiring speed is now (in Norm. writing mode):
$16.2\,\pi \,.\, 10^3$ div./s = 100 div./ms.

3.2.4. VERTICAL AMPLIFIERS

3.2.4.1. General information

– The adjustments of the vertical amplifier channels Y_A and Y_B are identical. The knobs, sockets and adjusting elements of channel Y_B are shown in brackets after those of channel Y_A.
– Unless otherwise stated the controls always occupy the same position as in the previous check.
– Adjust INTENS control R8 for adequate display brightness.

3.2.4.2. D.C. Balance (R6, R7)

– Depress WRITE switch SK25.
– Rotate potentiometer PERSISTENCE R10 entirely anti-clockwise.
– Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
– Set AC-0-DC switch SK16 (SK19) to 0.
– Set AMPL potentiometer R4 (R5) to CAL.
– Check that the trace does not shift if AMPL switch SK17 (SK18) is switched from .1 V/div to 2 mV/div. If necessary, readjust DC BAL R6 (R7). During the adjustment, the trace must be kept in the centre of the screen by means of POSITION potentiometer R11 (R12).
– Check that the position of the trace is the same in positions 2, 5, 10, 50 and 100 mV/cm of AMPL switch SK17 (SK18); the maximum allowable difference 0.2 div.

3.2.4.3. Gate current (R126, R326)

– Depress Y_A (Y_B) switch SK4 (SK5), BEAM SELECTOR switch A SK14 (B SK15) and + switch SK8.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Check that the trace does not jump when AC-0-DC switch SK16 (SK19) is switched from 0 to DC; if necessary, readjust potentiometer R126 (R326); Fig. 3.19. tolerance at final check 0.4 div.

3.2.4.4. Pre-amplifier (R64, R99, R264, R299)

– Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
– Set TIME/div switch SK2 to 10 ms and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 (SK19) to DC.
– Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
– Apply a square-wave voltage of 600 $mV_{p\text{-}p}$, 100 Hz, to Y_A (Y_B) input socket BU3 (BU5).
– Check that the pulse top is straight; if necessary, readjust potentiometer R99 (R299), Fig. 3.18.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Decrease the input voltage to 12 $mV_{p\text{-}p}$.
– Check that the pulse top is straight; if necessary, readjust potentiometer R64 (R264), Fig. 3.19.
– Check that in the ranges 50, 20, 10 and 5 mV/div of AMPL switch SK17 (SK18) the top is straight; tolerance 1 %.

3.2.4.5. Sensitivity (R111, R311)

– Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
– Set TIME/div switch SK2 to 2 ms and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 (SK19) to DC.
– Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
– Apply a voltage of exactly 600 mV_{p-p}, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
– Check that the trace height is exactly 6 div; if necessary, readjust potentiometer R111 (R311), Fig. 3.18.
– Check that the control range of AMPL potentiometer R4 (R5) is 1:2,6 to 1:4.

3.2.4.6. Input attenuator (C28, C29, C33, C34, C52, C228, C229, C233, C234, C235, C252)

– Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
– Set TIME/div switch SK2 to 50 μs and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 (SK19) to DC.
– Connect a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
– Check that no overshoot is visible (maximum pulse top errors 2 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table:

Position AMPL switch SK17 (18)	Signal to Y_A (Y_B) BU3 (5)	Adjust with	Trace height
2 mV/div	12 mV	C52 (C252)	6 div + or –2 %
5 mV/div	30 mV	C52 (C252)	6 div + or –2 %
10 mV/div	60 mV	C52 (C252)	6 div + or –2 %
20 mV/div	120 mV	C52 (C252)	6 div + or –2 %
50 mV/div	300 mV	C52 (C252)	6 div + or –2 %
.1 V/div	600 mV	C52 (C252)	6 div + or –2 %
.2 V/div	1,2 V	C28 (C228)	6 div + or –2 %
.5 V/div	3 V	C28 (C228)	6 div + or –2 %
1 V/div	6 V	C28 (C228)	6 div + or –2 %
2 V/div	12 V	C33 (C233)	6 div + or –2 %
5 V/div	30 V	C33 (C233)	6 div + or –2 %
10 V/div	60 V	C33 (C233)	6 div + or –2 %

– Set AMPL switches SK17 and SK18 to .1 V/div.
– Apply a square-wave voltage of 1,2 V_{p-p} repetition rate 10 kHz, rise time not exceeding 200 ns, to Y_A, input socket BU3 via a 2:1 dummy measuring probe consisting of a 1 MOhm resistor and a 30 pF trimmer in parallel. If higher voltages are available, a 10:1 attenuator probe may be used.
– Adjust the trimmer of the dummy probe for optimum square-wave response.
– Apply the input signal via the dummy probe to Y_B input socket BU5.
– Check that the top of the displayed pulse is straight; if necessary, readjust trimmer C235 (Fig. 3.19.).
– Connect, via the dummy probe, a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
– Check that neither overshoot nor rounding is visible (maximum pulse top errors 3 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table

Position AMPL switch SK17 (18)	Signal to 2:1 dummy	Adjust with	Trace height
.2 V/div	2,4 V	C29 (C229)	6 div + or –2 %
.5 V/div	6 V	C29 (C229)	6 div + or –2 %
1 V/div	12 V	C29 (C229)	6 div + or –2 %
2 V/div	24 V	C34 (C234)	6 div + or –2 %
5 V/div	60 V	C34 (C234)	6 div + or –2 %
10 V/div	60 V	C34 (C234)	3 div + or –3 %

3.2.4.7. Square-wave response (C901, C1001, C902, C1002, C62, C262, R113, R313)

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to .2 μs and TIME/div potentiometer R2 to CAL.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Set AC-0-DC switch SK16 (SK19) to AC.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns.
- Check the square-wave response. The pulse top errors must not exceed 3 %, maximum permissible overshoot is 2 %; if necessary, readjust trimmers C901 (C1001), C902 (C1002) and C62 (C262) or select a different value for resistor R113 (R313).
- Set AMPL switch SK17 (SK18) to 0.2 mV/div.
- Decrease the input voltage to 12 mV.
- Check that the pulse top errors do not exceed 3 % and the overshoot more than 2 %.

3.2.4.8. Bandwidth of the vertical amplifiers

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Check the bandwidth at a trace height of 6 div in accordance with the following table

Input sine wave on Y_A (Y_B) socket	*Frequency*	*Required trace height*
600 mV_{p-p}	100 kHz	6 div
600 mV_{p-p}	10 MHz	at least 4,2 div

3.2.4.9. Signal delay equality

Note: This check is only necessary if a new delay line has been fitted.

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 auto switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AC-0-DC switch SK16 (SK19) to AC.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 μs/div and TIME/div potentiometer R2 to CAL.
- Pull TB-MAGN. switch SK1 to position 5x.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns to input sockets Y_A BU3 and Y_B BU5. The connection cables to the input sockets should have the same length and characteristics.
- Make the pictures coincide with the aid of control knobs Y POSITION.
- Check that there is no difference in delay time between the amplifiers of channels Y_A and Y_B (0,1 div is acceptable). If necessary, reduce the length of one of the delay lines.

3.2.4.10. H.F. deflection and cross-talk

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR switches SK14 and SK15.
- Set AMPL switch SK17 (SK18) to 50 mV/div and AMPL potentiometer R4 (R5) to CAL.
- Apply a sine-wave voltage of 1,2 V_{p-p}, frequency 3 MHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the peaks of the signal can be displayed fairly undistortedly within the graticule, using POSITION potentiometer R11 (R12).
- Set AMPL switches SK17 & SK18 to .1 V/div and AMPL potentiometers R4 & R5 to CAL.
- Apply a sine-wave signal 1,2 V, frequency 3 MHz, to Y_A input socket BU3.
- Set AC-0-DC switch SK19 to 0.
- Check that the height of the Y_B trace does not exceed 0,2 div.
- Set AMPL switches SK17 & SK18 to 50 mV/div and AMPL potentiometers R4 & R5 to CAL.
- Apply the input signal to Y_B input socket BU5.
- Set AC-0-DC switch SK16 to 0.
- Check that the height of the Y_A trace does not exceed 0,2 div.

3.2.5. TRIGGERING

3.2.5.1. Trigger pre-amplifier (R414)

– Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
– Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
– Set AC-0-DC switch SK16 to AC.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
– Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
– Set LEVEL potentiometer R3 to such a position that the trace starts at the zero level of the sine-wave.
– Depress DC switch SK12.
– Check that the trace starts at the same point; if necessary, readjust potentiometer R414 (Fig. 3.14.).
– Decrease the input voltage to 80 mV.
– Adjust LEVEL potentiometer R3 for a triggered display.
– Check that the display is still triggered when AC switch SK11 is depressed.
– Depress BEAM SELECTOR switch B SK15, Y_B switch SK5 and DC switch SK12.
– Apply the 80 mV input signal to Y_B socket BU5.
– Set AMPL switch SK18 to .1 V/div and AMPL potentiometer R5 to CAL.
– Adjust LEVEL potentiometer R3 for a triggered display.
– Depress AC switch SK11; the starting point of the trace must not move more than 1 div.

3.2.5.2. Long-tailed pair circuit (R424)

– Depress Y_A switch SK4, – switch SK9, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
– Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 to AC.
– Apply a sine-wave voltage of 80 mV_{p-p}, frequency 2 kHz, to Y_A socket BU3.
– Check that the display remains stationary when LEVEL potentiometer R3 is rotated from fully anti-clock to fully clockwise; if necessary, readjust potentiometer R424 (Fig. 3.17.).

3.2.5.3. Trigger slope

– Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
– Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
– Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
– Adjust LEVEL potentiometer R3 for a stationary display.
– Check that the display starts with the positive slope of the signal.
– Depress – switch SK9.
– Check that the display starts with the negative slope of the signal.

3.2.5.4. Level range with external triggering

– Depress EXT switch SK6, AC switch SK11, + switch SK8 and BEAM SELECTOR switch A SK14.
– Set AMPL switch SK17 to 10 V/div and AMPL potentiometer R4 to CAL.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
– Apply a sine-wave voltage of 20 V_{p-p}, frequency 2 kHz, to both TRIGG input socket BU2 and Y_A input socket BU3.
– Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
– Depress – switch SK9 and repeat the check.

3.2.5.5. Level and level range

– Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
– Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
– Apply a sine-wave voltage of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
– Check that the starting point of the trace moves upwards when LEVEL potentiometer R3 is turned clockwise.
– Check that the starting point of the trace can be shifted over 5 div by means of LEVEL potentiometer R3.
– Depress AC switch SK11.

– Set AMPL switch SK17 to 50 mV/div.
– Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
– Check AMPL SK17 switch to 20 mV/div.
– Check that the time-base generator does not cut out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.

3.2.5.6. Mains triggering

– Depress EXT switch SK6, + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
– Set TIME/div switch SK2 to 20 ms and TIME/div potentiometer R2 to CAL.
– Apply a voltage with the mains frequency to Y_A input socket BU3; trace height 1 div.
– Check that the oscilloscope displays a moving sine wave.
– Depress MAINS switch SK7.
– Check that the display is stationary.

3.2.5.7. Trigger sensitivity

– Set AC-0-DC switches SK16 and SK19 to DC.
– Set LEVEL potentiometer R3 to obtain a stationary display.
– Set TIME/div switch SK2 so that a reasonable number of cycles is displayed.
– Check the trigger sensitivity in accordance with the following table.

Input signal to	*Frequency (sine wave)*	*Depress source switch*	*Depress mode switch*	*Depress BEAM SELECTOR*	*Triggering at*
Y_A BU3	20 Hz	Y_A SK4	AUTO SK10	A SK14	0,8 div
	10 MHz				0,8 div
	20 Hz		AC SK11		0,8 div
	10 Hz				0,8 div
	5 Hz		DC SK12		0,8 div
	10 MHz				0,8 div
Y_B BU5	20 Hz	Y_B SK5	AUTO SK10	B SK15	0,8 div
	10 MHz				0,8 div
TRIGG BU2 & Y_B BU5	20 Hz	EXT SK6		B SK15	0,8 V
	10 MHz				0,8 V

3.2.5.8. Single-sweep operation

– Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
– Depress WRITE switch SK25.
– Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
– Set AMPL switch SK17 to 50 mV/div.
– Set TIME/div switch SK2 to 50 ms/div.
– Apply a sine-wave of 600 mV, frequency 1 kHz to Y_A input socket BU3.
– Depress AUTO switch SK10 and Y_A switch SK4.
– Set AC-0-DC switch SK16 to AC.
– Set LEVEL potentiometer R3 to its mid-position.
– Depress SINGLE switch SK13 (RESET lamp LA4 is out).
– Push RESET button SK26 (RESET lamp LA4 is out).
The sweep runs only once, and displays a trace. If necessary, readjust the stability, for this see point 3.2.3.1.
– Depress AC switch SK11.
– Set AC-0-DC switch SK16 to 0.
– Push RESET button SK26, and ascertain that its associated lamp (LA4) lights.
– Set AC-0-DC switch SK16 to AC.
The sweep runs only once, after the sweep is completed the RESET lamp (LA4) goes out.

3.2.6. TIME-BASE GENERATOR AND HORIZONTAL AMPLIFIER

Note: For adjustment of the stability (R553) see point 3.2.3.1.

3.2.6.1. Time coefficients (R534, R539, R618)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10, X MAGN switch SK1 and BEAM SELECTOR switch A SK14.
- Set TIME/div potentiometer R4 to CAL.
- Set LEVEL potentiometer R3 to its mid-position.
- Set TIME/div switch SK2 to .5 ms.
- Check that the length of the time-base is 10 to 10,5 div, if necessary, readjust potentiometer R618 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 μs.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R534 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 ms.
- Change the repetition time of the input signal to 20 ms.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R539 (Fig. 3.17.).
- Check that in the other positions of TIME/div switch SK2 the 8 centre periods have a total width of 8 div + or −4 % (the repetition time of the input signal must always correspond to the setting of TIME/div switch SK2).
- Check that the length of the time-base line is 10 to 12 div in all positions of TIME/div switch SK2.
- Check that the control range of TIME/div potentiometer R2 is 1:2,6 to 1:5.

3.2.6.2. Magnification and shift (R617)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10 and BEAM SELECTOR A SK14.
- Set TIME/div switch SK2 to 20 μs and TIME/div potentiometer R2 to CAL.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Pull X MAGN switch SK1 to x5.
- Shift every cycle on to the screen by means of X POSITION potentiometer R1 and check that each cycle has a width of 5 div + or −2 %; if necessary, readjust potentiometer R617 (Fig. 3.17.).
- Check that with X POSITION potentiometer R1 the beginning and the end of the time-base line can be displayed within the graticule.
- Set TIME/div switch SK2 to .2 μs.
- Change the repetition time of the input signal to .2 μs.
- Check that the widths of all periods are equal within + or −2 %.

3.2.7. MAINS VOLTAGE FLUCTUATIONS

- Vary the mains voltage + and −10 % with respect to the nominal mains voltage as indicated by the voltage adapter.
- Check that the vertical and horizontal deflection are not affected and that the brightness does not change.

3.2.8. BEAM SELECTION

- Depress X MAGN switch SK1 to x1.
- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 1 ms.
- Set AMPL switches SK17 and SK18 to .1 V/div.
- Depress BEAM SELECTOR switch A SK14.
- Check that only the channel Y_A time-base line is visible.
- Release BEAM SELECTOR switch A SK14 and depress B SK15.
- Check that only the channel Y_B time-base line is visible.

3.2.9. X-Y OPERATION (R601)

- Depress AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR SWITCHES A SK14 and B SK15.
- Set TIME/div switch SK2 to 5 ms.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set POSITION potentiometer R11 to its mid-position.
- Set AC-0-DC switch SK16 to AC.
- Set X POSITION potentiometer R1 to such a position that the time-base lines start at the beginning of the measuring graticule.
- Centre the Y_B time-base line by means of POSITION potentiometer R12.
- Set TIME/div switch SK2 to position X via Y_A.
- Check that the spot is displayed in the centre of the screen; tolerance + or −5 div.
- Check that no Y_A trace is visible, also when POSITION potentiometer R11 is rotated.
- Apply a sine-wave voltage of 800 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Centre the trace by means of X POSITION potentiometer R1.
- Check that the trace width is 8 div + or −0,4 div; if necessary, readjust potentiometer R601 (Fig. 3.17.).
- Increase the frequency of the input voltage to 1 MHz.
- Check that the trace width is at least 6 div.

3.2.10. OUTPUT SOCKETS

3.2.10.1. Calibration voltage on CAL socket BU1 (R761)

- Check, with the aid of an accurate peak-peak voltmeter, that the voltage on CAL socket BU1 has a value of 600 mV_{p-p} + or −0,5 %; if necessary, readjust potentiometer R761 (Fig. 3.17.).
- Check that the pulse does not show overshoot and that the repetition frequency is 2 kHz + or −20 %.

3.2.10.2. Time-base voltage on TB OUT socket BU6

- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 2 ms.
- Check that the amplitude of the sawtooth voltage on TB OUT socket BU6 is 6 V + or −20 %, if terminated with a resistor of 1 MΩ.

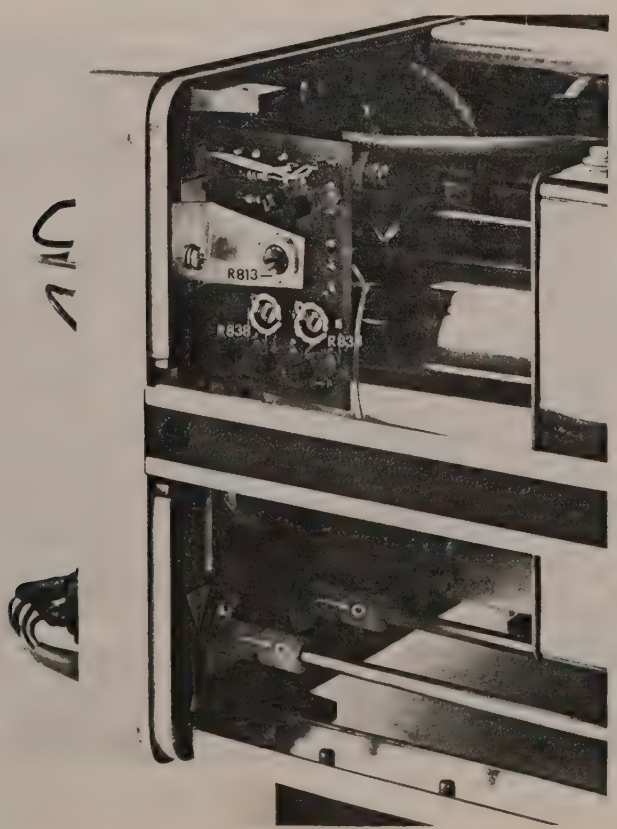


Fig. 3.16. Adjusting and dismantling

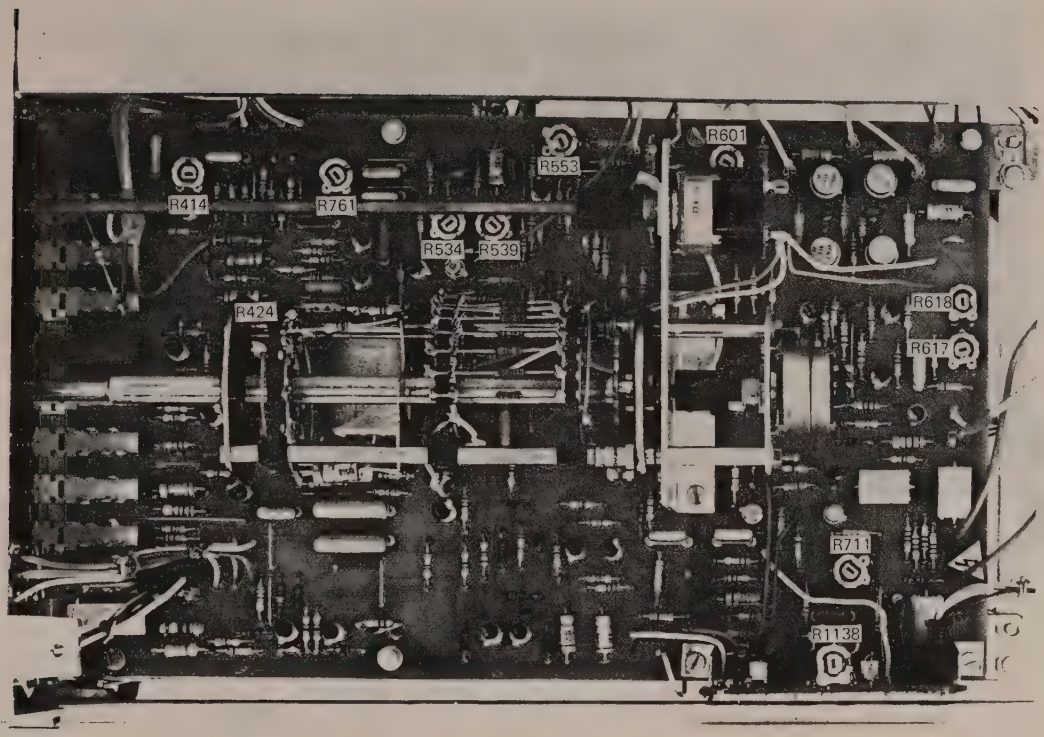


Fig. 3.17. Adjusting

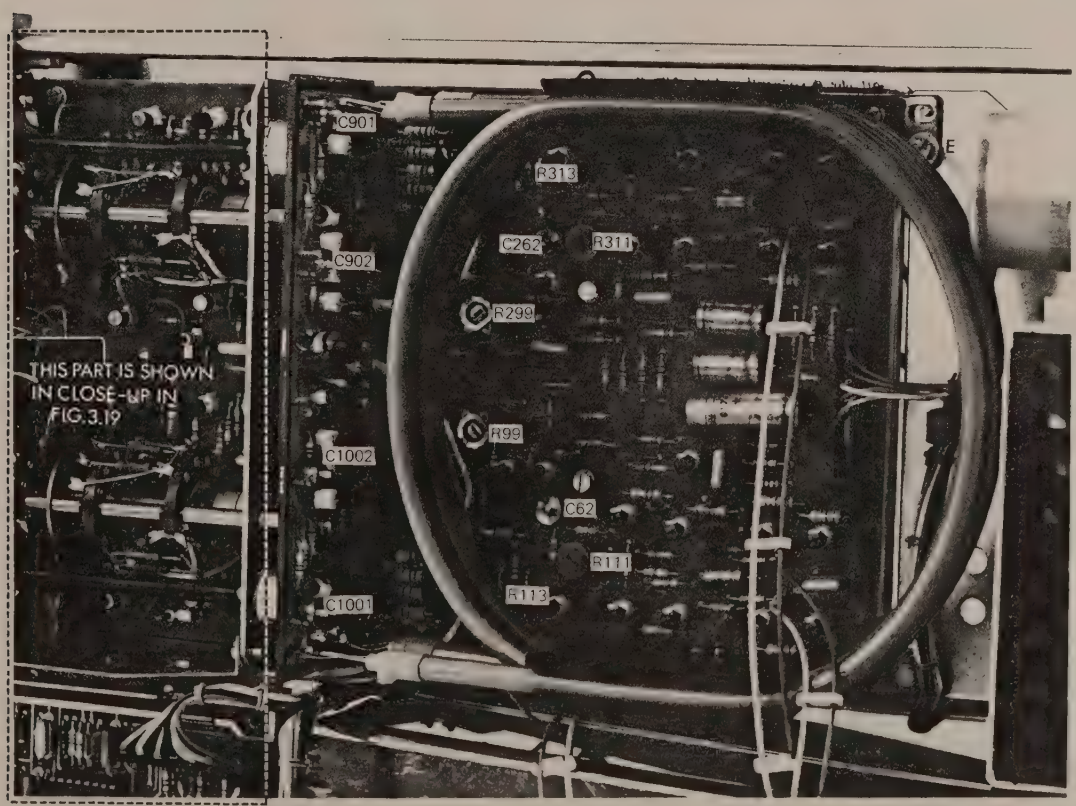
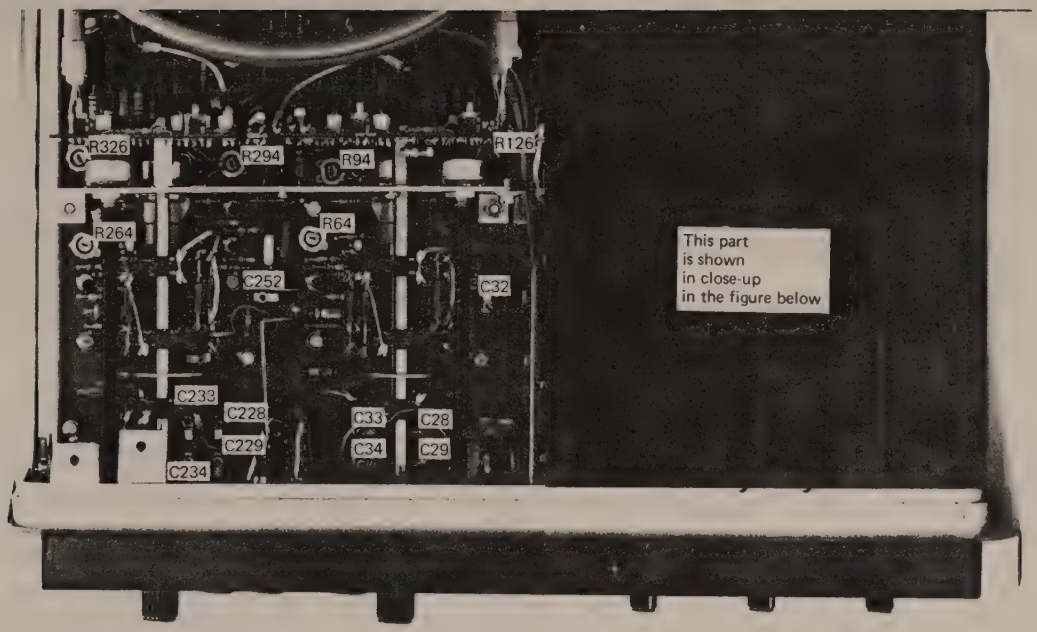


Fig. 3.18. Adjusting and dismantling



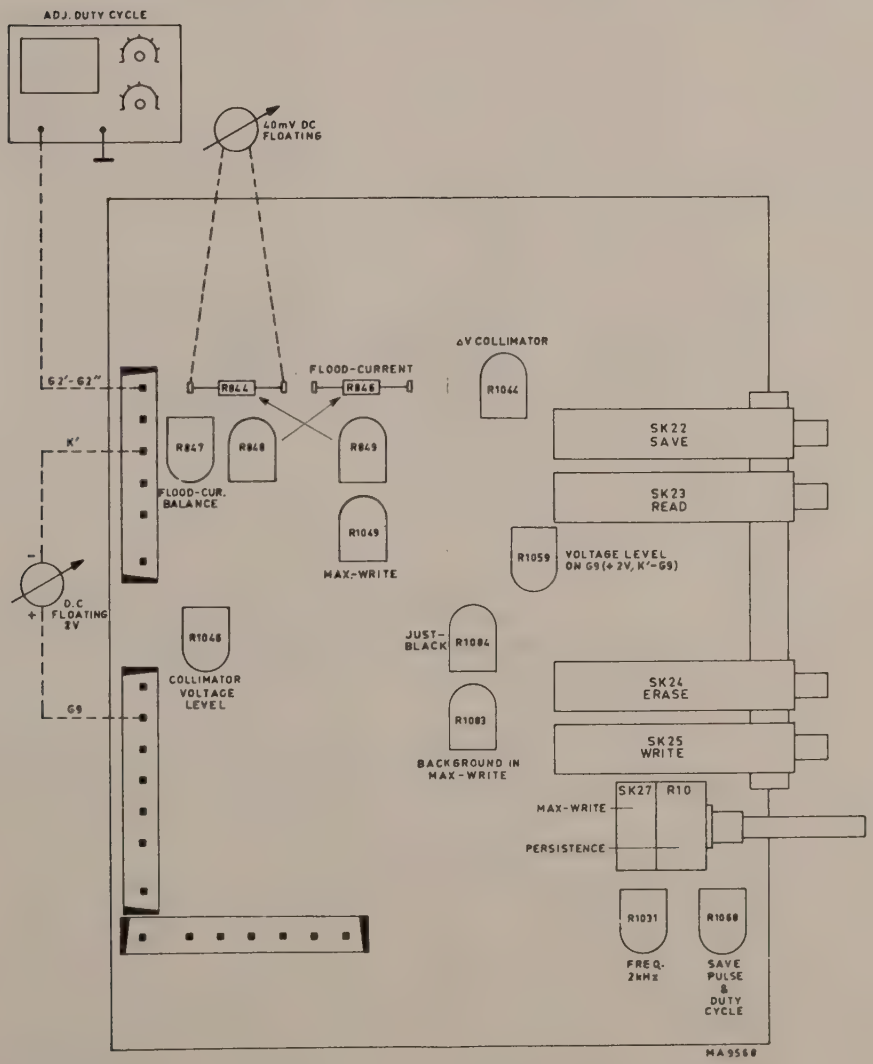


Fig. 3.19. Adjusting

3.3. Dismantling the instrument

3.3.1. WARNING

The opening of parts of the instrument or the removal of covers is likely to expose live conductors.
The instrument must, therefore, be disconnected from all voltage sources before any opening of parts or removal of covers is started.
If the E.H.T. connector of the c.r.t. is disconnected, both connector and c.r.t. must be discharged immediately by shortening them to earth.

3.3.2. KNOBS

3.3.2.1. Knobs of Y POSITION potentiometers R11 & R12 and AC-0-DC switches SK16 & SK19

These knobs can be pulled off the shaft.

3.3.2.2. Single knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the knob off the shaft.

3.3.2.3. Double knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the inner knob off the shaft.
- Slacken nut C.
- Pull the outer knob off the shaft.

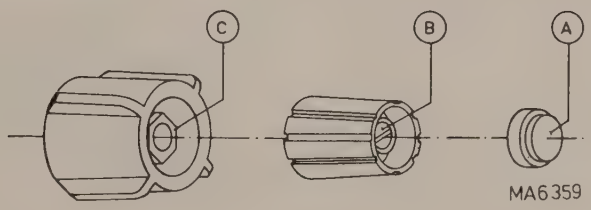


Fig. 3.20. Knobs

3.3.3. BEZEL

- Slightly lift the lower part of the bezel and swivel it upwards.
- Subsequently mask, contrast filter and measuring graticule can be removed.

3.3.4. CABINET PLATES

Top and bottom cabinet plates can be taken off after removing four screws for each plate.

3.3.5. PILOT LAMP

– Remove the bezel with graticule, filter and mask.
– Squeeze lamp holder flanges slightly inwards and push the lamp holder out of the frame. Be careful not to mechanically load the soldering tags of the lamp holder, as they break easily.
The bulb is then accessible:

To refit:
– Push the lamp holder back in its opening until the hooks on the flanges snap over the frame.

3.3.6. TEXT PLATE OF C.R.T. CONTROLS

– Remove the bezel with graticule filter and mask.
– Remove the knobs of the PERSISTENCE, FOCUS and INTENS potentiometers.
– Remove the fixing nut around the shaft of the INTENS potentiometer.

3.3.7. STORAGE UNIT

– Unplug all connectors on the storage board.
– Remove the bezel with graticule, filter and mask.
– Remove one screw J (Fig. 3.22.).
– Remove the two recessed-head screws G (Fig. 3.22.) and belonging clamping devices with which the storage board is fitted to the front panel.
– Slide the board out of the instrument.

3.3.8. TIME-BASE UNIT

– Remove the X POSITION, TIME/div and LEVEL knobs.
– Unplug all connectors on the time-base board (a few connectors can be unplugged at the vertical amplifier board).
– Remove two screws A (Fig. 3.21.).
– Remove two screws B (Fig. 3.21.).
– Remove two screws and nuts C (Fig. 3.21.).
– Lift the unit out of the instrument.
– When refitting the unit, make sure that the screening plate between time-base and vertical amplifier unit clicks into place over the cross bars of the frame.

Note:

In order to maintain the mechanical strength of the oscilloscope, the time-base unit and the vertical amplifier unit must not be removed at the same time.

3.3.9. VERTICAL AMPLIFIER UNIT

– Remove the AC-0-DC, AMPL and POSITION knobs.
– Set the AC-0-DC switches SK16 & 19 to 0.
– Remove all connectors on the amplifier board.
– Remove two screws D (Fig. 3.22.).
– Remove two screws E (Fig. 3.18.).
– Remove two screws C (Fig. 3.21.).
– Lift the unit out of the instrument.
– When refitting the unit, make sure that the AC-0-DC switches are in 0 position and that the screening plate between time-base and amplifier unit clicks into place over the cross bars of the frame.

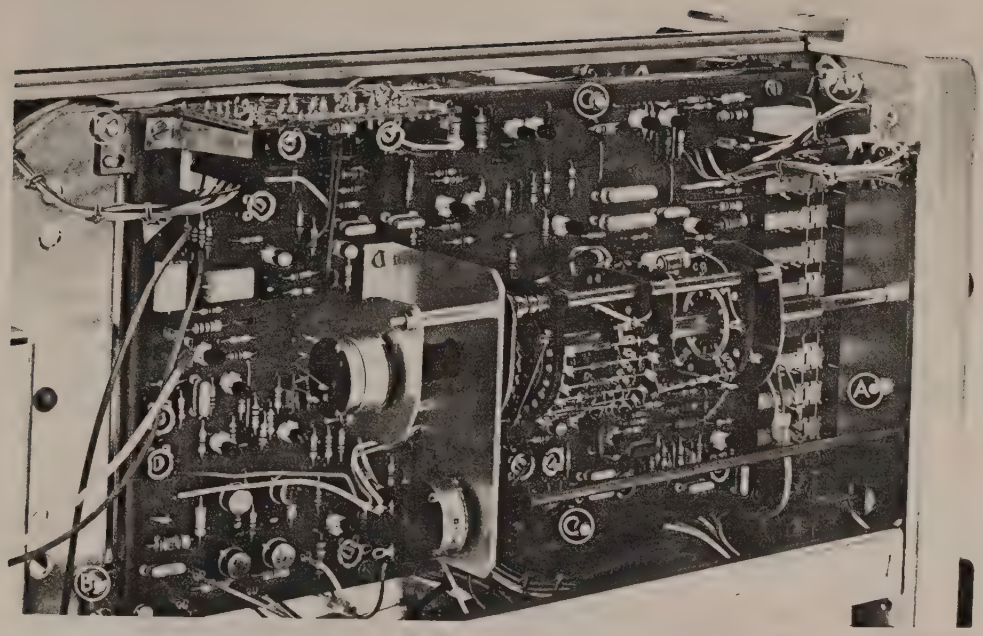


Fig. 3.21. Dismantling

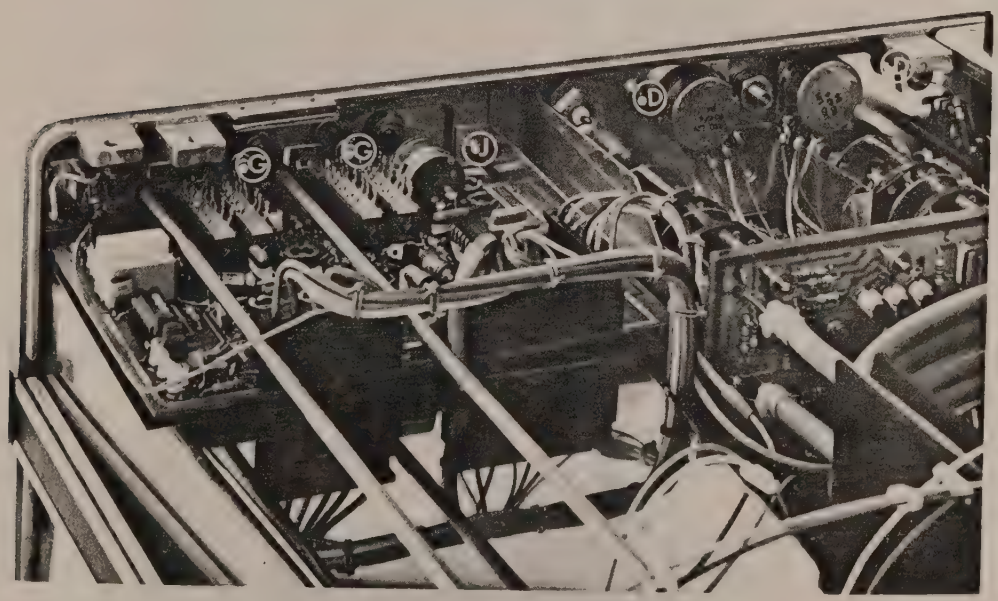


Fig. 3.22. Dismantling

3.3.10. MAIN TEXT PLATE

- Remove all knobs except those of the c.r.t. controls.
- Set the AC-0-DC switches SK16 & 19 to 0.
- Remove the time-base unit.
- Remove the earth connector BU4.
- Remove the retaining clips of the bearings for the X POSITION and the LEVEL potentiometer, and the bearings themselves.
- Unplug the connector of the CAL socket.
- Remove the retaining clip of the CAL socket, and the CAL socket itself.
- Take the text plate out of the front panel.

3.3.11. CATHODE-RAY TUBE

Attention: Be very careful with the side connections of the c.r.t. If these pins are bent, the c.r.t. is likely to develop a gas leak.

- Slacken the brace around the c.r.t. neck by means of screw F.
- Slacken screws K.
- Remove the tube base.
- Remove magnets T and pull the yoke (Y) from the c.r.t. neck.
- Slacken the four screws H and remove the plates.
- Remove the mu-metal screening tube S.
- Remove the bezel with graticule, filter and mask.
- Remove the rubber collar around the front side of the c.r.t.
- Push the c.r.t. to the rear side of the oscilloscope and remove the connections around the c.r.t. neck.
- Push the c.r.t. to the front side of the oscilloscope and remove the connections (discharge connectors and c.r.t. immediately by shortening them to earth).
- Carefully withdraw the c.r.t. through the front panel of the instrument.
- Refitting of the c.r.t. is done in the reverse order.
- Move the c.r.t. in such a way that the tube face is flush with the front of the oscilloscope.
- If the yoke and the rubber sleeve around the neck of the c.r.t. must be slid over the neck of a remplacement tube, the use of industrial talcum powder is strongly recommended.

Attention: After replacement of the tube, the aperatus must be checked and adjusted according to chapter 3.2. "Checking and adjusting". Then, after a burning in time of about 100 hours the apparatus must be checked and eventually adjusted again.

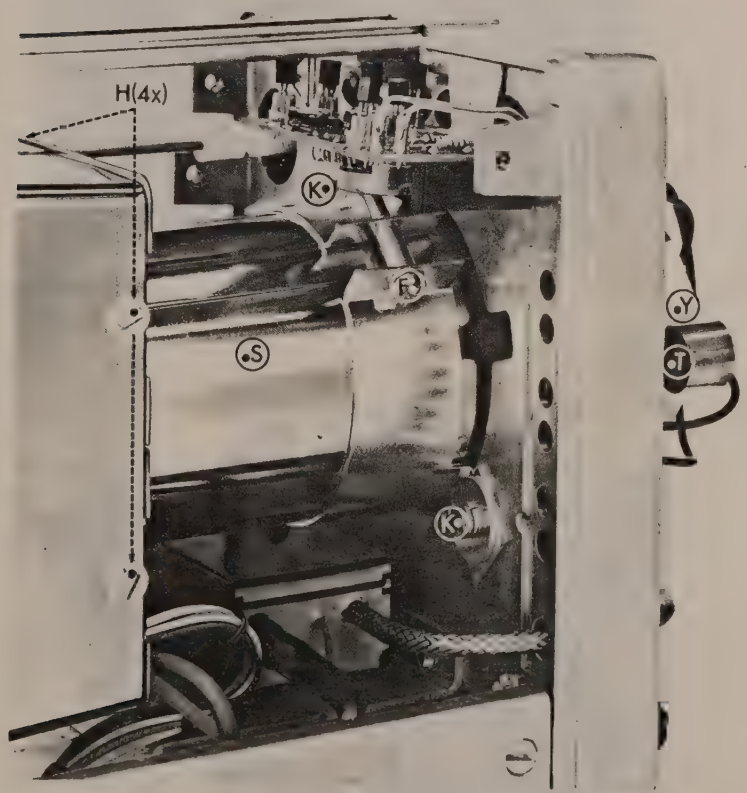


Fig. 3.23. Dismantling

3.3.12. MAINS TRANSFORMER

– Remove the rear cover (three screws X, Fig. 2.1.).
– Unsolder and unplug the relevant connections.
– Remove the three screws L (Fig. 3.24.).
– Take the transformer with voltage adapter and capacitor out of the instrument.

3.3.13. POWER SUPPLY BOARD

If only the components on the board must be made accessible, proceed as follows:
– Remove the rear cover (three screws X, Fig. 2.1.).
– Remove the rear panel with the sockets, by removing the three screws and spacers M (Fig. 3.15.).
– Unplug all connectors on the power supply board.
– If necessary, remove valve holder, magnets and the yoke of the c.r.t. (Fig. 3.23. & 3.25.).
– Remove the five screws N (Fig. 3.15.).
– Swivel the board out of the instrument (Fig. 3.25.).

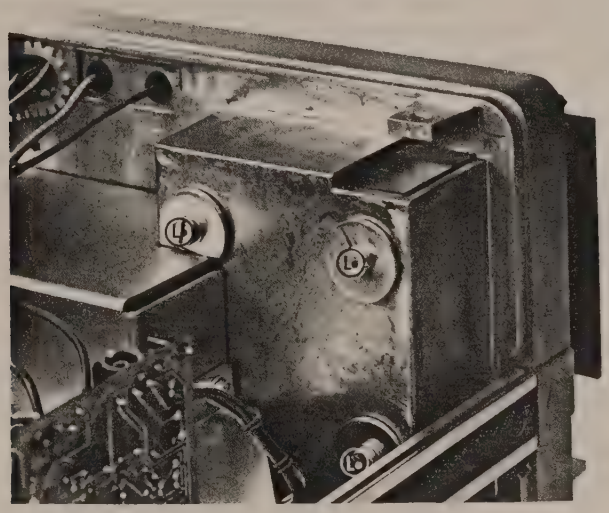


Fig. 3.24. Dismantling

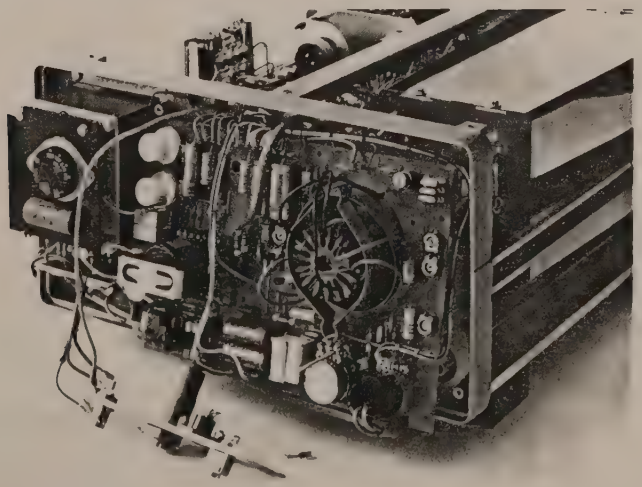


Fig. 3.25. Supply unit swiveled out

If the wiring board must be replaced, also unsolder the remaining connection wires along the sides of the board, including the connection of the mains cable to the POWER ON switch and the connections to the valve holder of the c.r.t.

Note: When replacing the board, make sure that the shafts of the FOCUS and INTENS potentiometers fit properly in the coupling bushes 0 (Fig. 3.16.).

3.3.14. VOLTAGE QUADRUPLER

- Remove the rear cover (three screws X, Fig. 2.1.).
- Remove the E.H.T. connector and discharge the E.H.T. and c.r.t. immediately by shortening them to earth.
- Unsolder the E.H.T. lead at point P on the supply unit (Fig. 3.15.).
- Unsolder the earth wire of the quadrupler.
- Slightly squeeze the quadrupler flanges inside the cable compartment together and pull the quadrupler out.

3.3.15. REPLACING A PUSH-BUTTON SWITCH

- Remove the storage unit in accordance with section 3.3.7. for replacing a switch in this unit.
- Remove the time-base unit in accordance with section 3.3.8., for replacing a switch in this unit.
- Remove the vertical amplifier unit in accordance with section 3.3.9., for replacing a switch in this unit.
- Straighten the 4 retaining plugs of the relevant switches as shown in Fig. 3.26.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-wiring board.
- Bend the 4 retaining lugs back to their original positions.

N.B.: The YA and + switch are not soldered, so it is sufficient to just straighten the 4 retaining lugs to remove them.

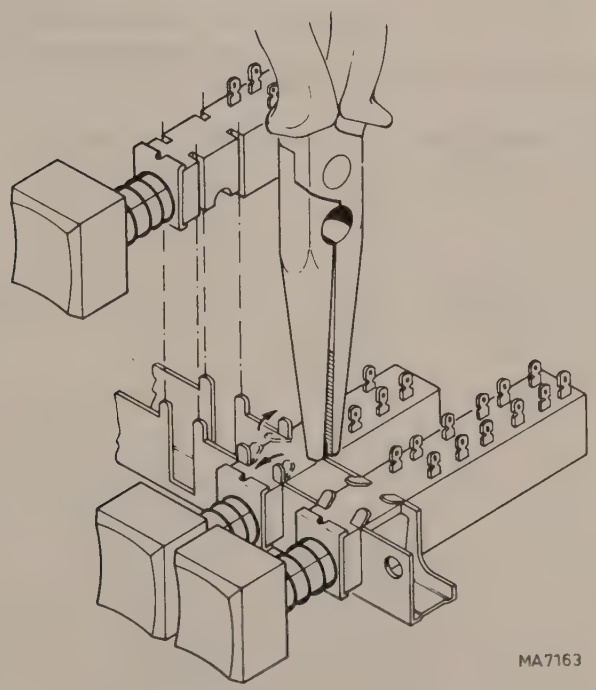


Fig. 3.26. Replacing a push-button switch

3.4. Information for assistance in fault-finding

3.4.1. MAINS TRANSFORMER DATA

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram in the form of a table.

3.4.2. VOLTAGES AND WAVEFORMS IN THE INSTRUMENT

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator and storage unit are shown at the relevant points on the circuit diagram.

The waveforms have been measured under the following conditions:
- Input signal on Y_A socket BU3: 2 kHz sine-wave voltage for 6 cm deflection.
- LEVEL potentiometer R3 in mid-position.
- TIME/div switch SK2 to .2 ms and X MAGN switch SK1 to x1.
- Y_A, + and AUTO push-buttons SK4, SK8 and SK10 depressed.
- AMPL switch SK17 to 1 V/div.

The voltage values are typical and may slightly differ per instrument.

3.4.3. REMARK

In case of a defect is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:
- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.5. Information concerning accessories

3.5.1. FRONT COVER

This is a plastic cover to protect the oscilloscope front during transport. The cover contains storage space for two passive probes and two BNC to 4 mm adapters. This storage space is accessible after the cover plate has been removed. To this end, bend the lugs A (Fig. 3.27.) slightly inwards and lift off the cover plate.

Fig. 3.27. Front cover

3.5.2. ADAPTER PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm banana plugs.

Fig. 3.28. Adapter PM 9051

3.5.3. ATTENUATOR PROBE SETS PM 9326 and PM 9327 (Fig. 3.29.)

These passive probe sets are equal but for the length of the probe cable, which is 1,15 m for the PM 9326 and 2 m for the PM 9327.

The sets consist of:

1 probe cable	Fig. 3.29. item 1
1 earth lead 15 cm	Fig. 3.29. item 2
1 earth lead 30 cm	Fig. 3.29. item 3
1 measuring probe 1:1 (black)	Fig. 3.29. item 4
1 test pin	Fig. 3.29. item 5
1 test hook	Fig. 3.29. item 6
1 attenuator probe 1:10 (grey)	Fig. 3.29. item 7
1 test clip	Fig. 3.29. item 8
1 box	Fig. 3.29. item 9

The measuring probe and the earth lead can be simply pulled from the cable. The test clip, test pin and test hook are screwed on to the measuring probe.

For ordering numbers of these parts, see list 3.6.3.1.

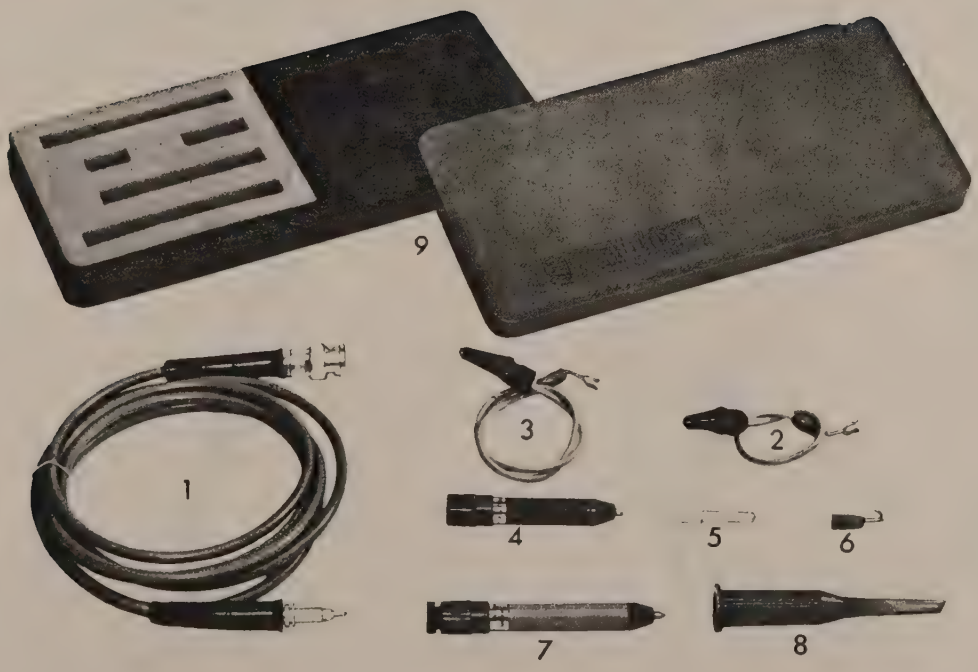


Fig. 3.29. Attenuator probe set PM 9326 (PM 9327)

3.5.3.1. Technical data

Attenuation	1:10 ±3 %
Input impedance	10 MOhm//10 pF
Max. permissible input voltage	1000 V_{p-p}

Maximum d.c. component 500 V with the blocking capacitor included into the circuit.

3.5.3.2. Adjustment (Fig. 3.30.)

- Unscrew the probe locking nut by turning it anti-clockwise.
- Rotate the probe body to change the capacitance while watching the display for the desired waveform.
- When compensation is completed, carefully turn the locking nut clockwise, to lock it without disturbing the adjustment.

The attenuator probe causes distortion if it has not been properly adjusted.

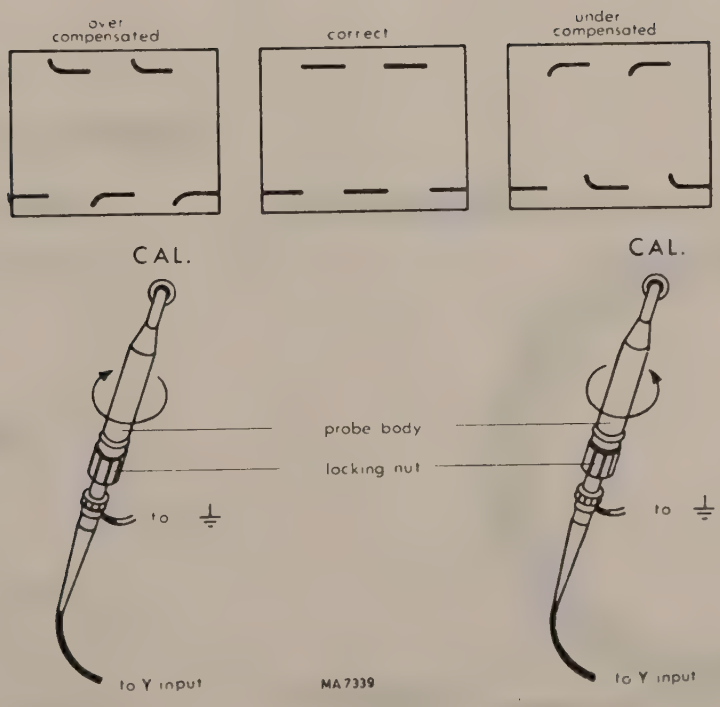


Fig. 3.30. Adjusting an attenuator probe

3.5.4. ATTENUATOR PROBE SETS PM 9336 and PM 9336L

The PM 9336 is a 10x attenuator probe, designed for oscilloscopes up to 25 MHz, having a BNC input jack and 10 to 35 pF input capacitance, paralleled by 1 MΩ. The PM 9336L is a similar probe with a cable length of 2.5 m.

The set consists of:

1 probe assembly	Fig. 3.31. item 1
5 soldering terminals	Fig. 3.31. item 2
1 test hook	Fig. 3.31. item 3
2 spare test hook sleeves	Fig. 3.31. item 4
1 protective cap	Fig. 3.31. item 5
1 probe holder	Fig. 3.31. item 6
2 probe tips	Fig. 3.31. item 7
1 earthing cord	Fig. 3.31. item 8
1 box	item 9

For ordering numbers of these parts, see list 3.6.3.2.

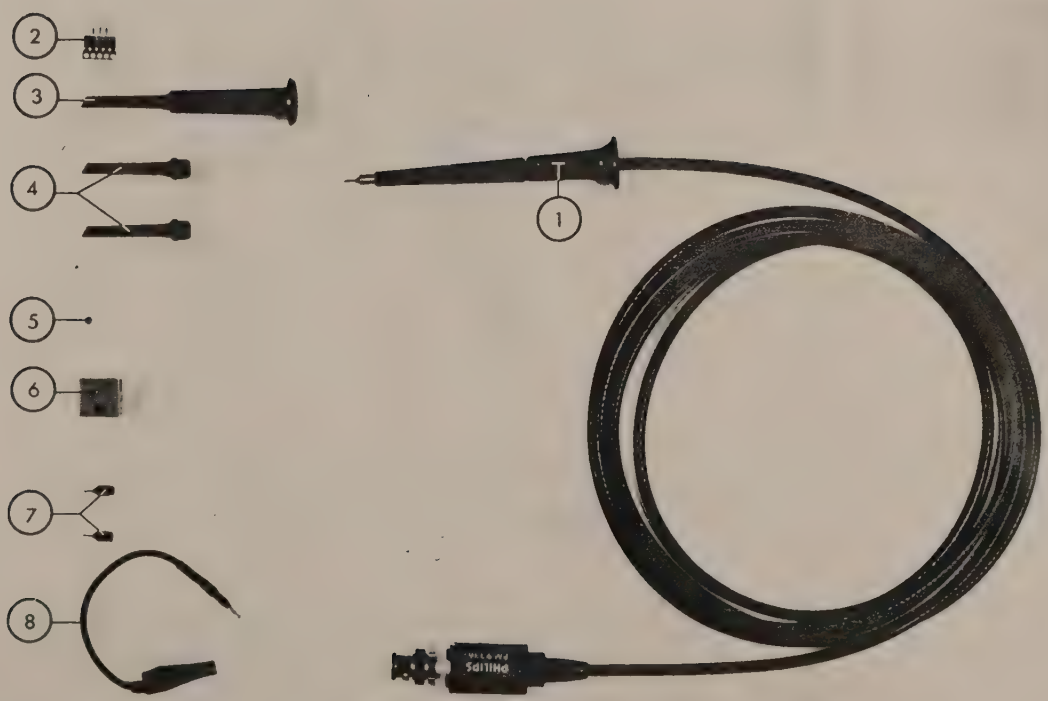


Fig. 3.31. Attenuator probe set PM 9336 (PM 9336L)

3.5.4.1. Technical data

Attenuation	1:10 ±3 %		
Input resistance	PM 9336	10 MOhm	±2 %
	PM 9336L	10 MOhm	±2 %
Input capacitance	PM 9336	11 pF	±1 pF
	PM 9336L	14 pF	±1 pF
Maximum allowable input voltage	500 V (D.C. + A.C. peak)		

3.5.4.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to socket CAL of the oscilloscope.
A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples

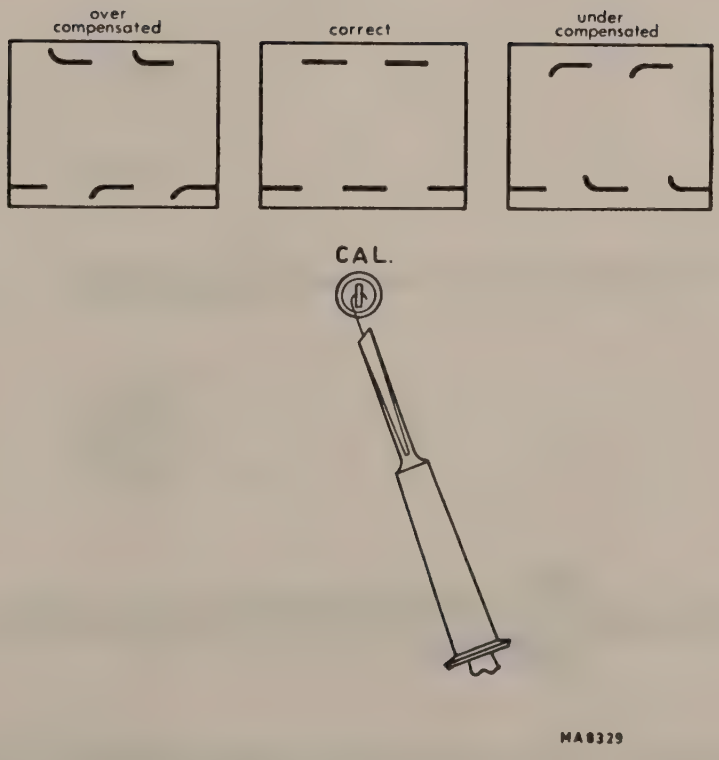


Fig. 3.32. Probe compensation

3.5.5. 1:1 PROBE SETS PM 9335 and PM 9335L

The PM 9335 is a passive probe without signal attenuation for use with oscilloscope, counters and voltmeters having a high input impedance and a BNC input socket.
The cable design is such that the reflections due to the instrument's capacitive load are absorbed.
The useful range of this probe is restricted to d.c. and l.f. applications (up to 10 MHz).
The PM 9335L is a similar probe with a cable length of 2,5 m.

The set consists of:

1 test hook	Fig. 3.33. item 1
2 spare test hook sleeves	Fig. 3.33. item 2
2 spare probe tips	Fig. 3.33. item 3
1 protective cap	Fig. 3.33. item 4
1 earthing lead	Fig. 3.33. item 5
1 probe holder	Fig. 3.33. item 6
1 probe assembly	Fig. 3.33. item 7
1 box	item 8

For ordering numbers of these parts, see list 3.6.3.3.

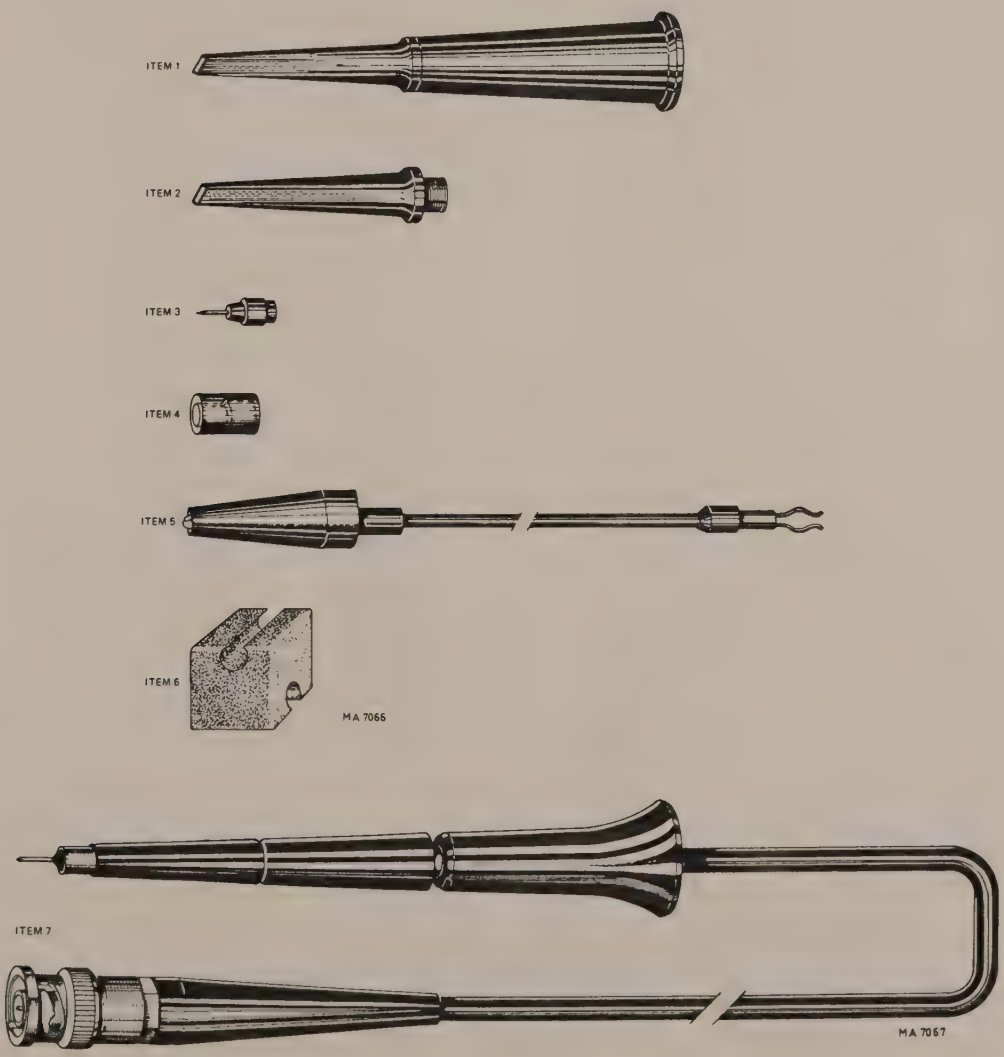


Fig. 3.33. Probe set PM 9335

3.5.5.1. Technical data

Attenuation	1:1
Input resistance	1 MOhm
Input capacitance	45 ±5 pF + input cap. of measuring instrument

Max. allowable input voltage

D.C.	500 V
A.C. peak-to-peak	500 V derating at higher frequencies with $\frac{500\ V}{MHz}$
A.C. peak + D.C.	500 V

Dimensions	**L**	**W**	**H**	
Probe body	105			mm
Cable	1.5			m
Box	230	104	24	mm

3.5.6. 2 kV ATTENUATOR SET PM 9358

The PM 9358 is a 100x attenuator probe which can handle signals up to 2 kV_{rms}. The probe has been designed for use with oscilloscopes having a bandwidth up to 150 MHz, a BNC input jack and an input impedance of 1 MΩ paralleled by 14 to 21 pF.

The set consists of:

1 probe assembly	Fig. 3.34. item 1
5 soldering terminals	Fig. 3.34. item 2
1 test hook	Fig. 3.34. item 3
1 spare test hook sleeve	Fig. 3.34. item 4
1 protective cap	Fig. 3.34. item 5
1 insulating cap	Fig. 3.34. item 6
1 probe holder	Fig. 3.34. item 7
2 spare test pins	Fig. 3.34. item 8
1 earthing cord	Fig. 3.34. item 9
1 box	item 10

For ordering numbers of these parts, see list 3.6.3.4.

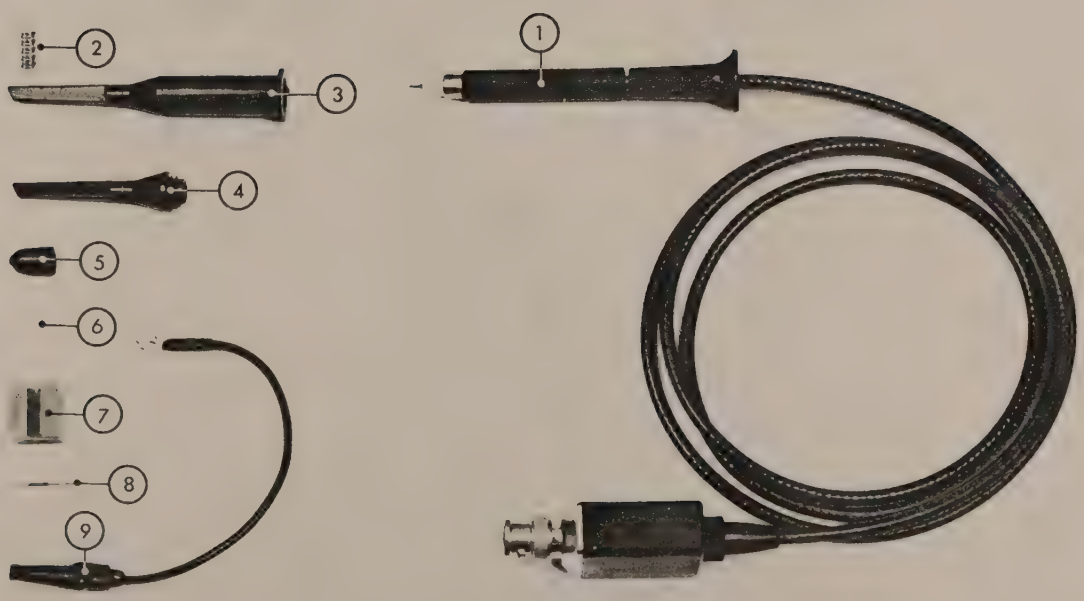


Fig. 3.34. Attenuator probe set PM 9358

3.5.6.1. Technical data

Attenuation		1:100 ±2 %
Input resistance		20 MOhm ±3 %
Input capacitance		2 pF ±0.3 pF
Max. allowable voltage DC or AC_{rms}		
Continuous	2 kV	
Under pulsed conditions	2 kV	Duty cycle 50 - 100 % dv/dt ⩽ 1000 V/ns Pulse rep. frequency ⩽ 1 MHz
	3 kV	Duty cycle 25 - 50 % dv/dt ⩽ 500 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 100 ms
	4 kV	Duty cycle 0 - 25 % dv/dt ⩽ 200 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 20 ms
Sine waves continuous	5,6 kV_{p-p}	For frequencies up to 1 MHz

3.5.6.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary. Connect the measuring pin to socket CAL of the oscilloscope. A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples:

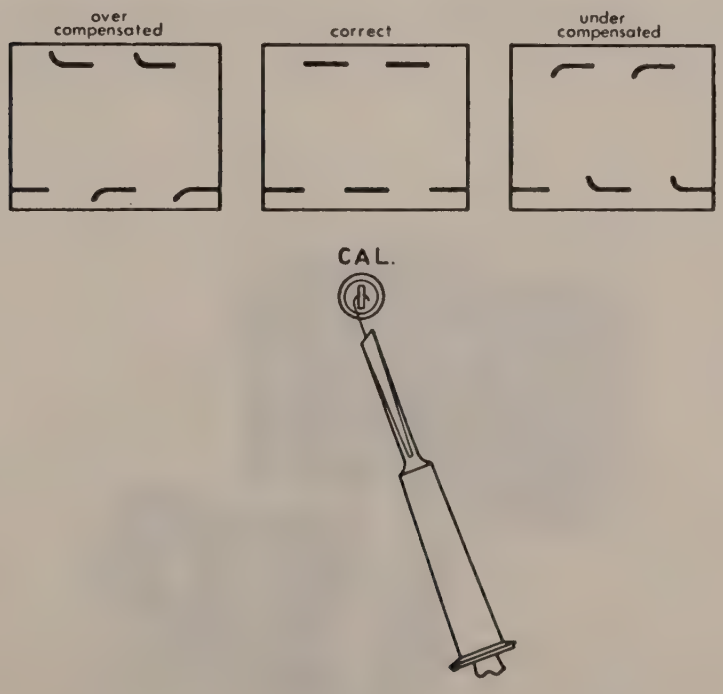


Fig. 3.35. Probe compensation

3.5.7. SET OF EAGLE CLIPS PM 9333

PM 9333 Set of eagle clips especially designed to probe difficult to reach signal sources, all types of wrapped wiring etc.

Each set contains:

10 eagle clips fitting the probes PM 9335, PM 9336 and PM 9336L
10 adapter pieces fitting the probes PM 9326 and PM 9327
10 adapter pieces fitting the micro-miniature probe PM 9352

Fig. 3.36. Adapter set PM 9333

3.5.8. MULTI-PURPOSE CAMERA PM 9380

Camera PM 9380 has been designed to photograph oscilloscope displays in a quick and simple way.
It incorporates the Polaroid instant photographic process which has the advantage that you can see the picture a few moments after you took it.

Fig. 3.37. Multi-purpose camera PM 9380

3.5.9. ADAPTER PM 9379

This adapter forms the connection between camera PM 9380 and oscilloscope PM 3234. The dimensions of the adapter are such, that the camera automatically focussed when the camera-adapter combination is held against the front of the oscilloscope.

NOTE

Together with this adapter, a supplementary lens PM 9373 must be used.

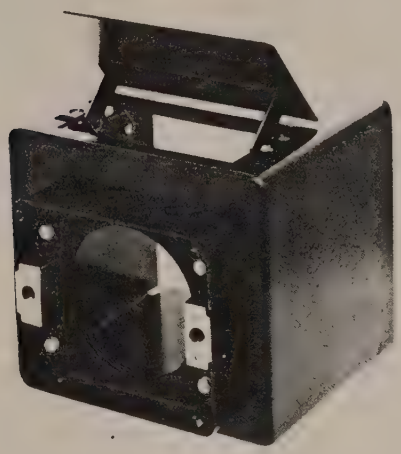


Fig. 3.38. Adapter PM 9379

3.6. Parts lists and diagrams (Subject to alteration without notice)

3.6.1. MECHANICAL PARTS

Item	*Fig.*	*Qty*	*Ordering number*	*Description*
1	3.39	1	5322 268 14052	Calibration terminal BU1 compl.
2	3.39	1	5322 268 10031	Calibration contact pin BU1
3	3.39	1	5322 325 84011	Grommet for BU1
4	3.39	1	5322 492 60799	Spring for BU1
5	3.39	1	5322 532 54198	Insulating ring for BU1
6	3.39	5	5322 414 34119	Control knob (R1, R2, R3, R4, R5)
7	3.39	4	5322 414 74014	Cover for control knob (grey)
8	3.39	3	5322 414 74016	Cover for control knob (blue)
9	3.39	3	5322 414 34081	Switch knob (SK3, SK17, SK18)
10	3.39	10	5322 276 14101	Push-button switch (SK4...SK13)
11	3.39	10	5322 414 24846	Knob for SK4...SK13
12	3.39	1	5322 455 84036	Text plate, front (big)
13	3.39	1	5322 276 10398	Reset pushbutton (compl.)
14	3.39	4	5322 267 10004	BNC socket (BU2, BU3, BU5, BU6)
15	3.39	4	5322 506 14001	Nut for BNC socket
16	3.39	3	5322 532 24319	Padding ring for BU2, BU3, BU5
17	3.39	2	5322 276 14103	Push-button switch (SK14, SK15)
18	3.39	2	5322 414 24845	Knob for SK14, SK15
19	3.39	2	5322 277 14047	Lever switch (SK16, SK19)
20	3.39	2	5322 414 25052	Knob for SK16 and SK19
21	3.39	1	5322 498 54046	Carrying handle
22	3.39	2	5322 500 14152	Screw for carr. handle
23	3.39	1	5322 462 54067	Tilting-bracket
24	3.39	2	5322 462 44067	Hinge for tilting-bracket
25	3.39	4	5322 462 40252	Foot
26	3.39	1	5322 535 80523	Earthing terminal (BU4)
27	3.39	1	5322 505 14178	Nut for BU4
28	3.39	2	5322 414 34108	Control knob (R11, R12)
29	3.39	2	5322 492 64377	Clamping spring for R11, R12
30	3.39	3	5322 414 34075	Control knob (R8, R9, R10)
31	3.39	3	5322 414 74015	Cover for control knob (R8, R9, R10)
32	3.39	3	5322 414 74028	Nut cover (R8, R9, R10)
33	3.39	4	5322 276 14102	Push-button switch (SK22...SK25)
34	3.39	1	5322 414 24911	Knob (red)
35	3.39	3	5322 414 14011	Knob (grey)
36	3.39	1	5322 381 10152	Lens
37	3.39	1	5322 455 84037	Text plate front (small)
38	3,39	1	5322 450 14002	Graticule
39	3.39	1	5322 480 34034	Contrast filter (grey)
39	3.39	1	5322 480 34043	Contrast filter (amber)
40	3.39	1	5322 480 34091	Contrast filter (blue)
41	3.39	1	5322 447 94228	Mask
42	3.39	1	5322 451 34002	Bezel
43	3.39	1	5322 447 94186	Cabinet plate (top)
44	3.39	1	5322 447 94167	Cabinet plate (bottom)
45	3.40-.41	2	5322 459 84004	Insert
45a	3.40	1	5322 447 94282	Front cast
45b	3.40	1	5322 447 94283	Rear cast

Item	Fig.	Qty	Ordering number	Description
46	3.40	1	5322 105 34009	Time-base switch, complete (SK2)
47	3.40	10	5322 255 40089	Transistor socket
48	3.40	6	5322 255 40038	Transistor socket
49	3.40	2	5322 492 64452	Fixing spring (magnet)
50	3.40	2	5322 526 24026	Cylindrical magnet
51	3.40	1	5322 255 70159	Valve socket for CRT
52	3.40	1	5322 466 85168	Earthing terminal
53	3.40	1	5322 405 94046	Clamp for earthing terminal
54	3.40	1	5322 267 40127	Socket 6 cont. (BU8)
55	3.40	1	5322 256 34019	Fuse holder
56	3.40	1	5322 455 84038	Text plate, rear
57	3.41	1	4822 272 10079	Voltage adaptor
58	3.41	2	5322 105 34008	Attenuator switch, complete (SK17, SK18)
59	3.41	2	5322 532 34079	Coupling piece for R4, R5
60	3.41	2	5322 462 70715	Plastic cap
61	3.41	2	5322 255 44053	S Clip (non-insulated)
61	3.41	2	5322 255 40106	S Clip (insulated)
62	3.41	1	5322 321 14001	Mains flex
63	3.41	2	5322 532 24321	Coupling piece for R8, R9
64	3.41	3	5322 255 24015	Lamp holder for La1
65	3.42	1	5322 447 94091	Front cover
66	3.42	1	5322 414 34086	Key
67	3.42	1	5322 492 54152	Compression spring
68	3.42	1	4822 530 70126	Fixing spring (Front cover)
69	3.42	1	5322 455 84009	Plate
70	3.40	1	5322 216 54107	Printed wiring board of power supply unit, complete with components
71	3.40	1	5322 216 54105	Automatic brightness cont. unit
72	3.40	1	5322 216 54108	Printed wiring board of time-base unit, complete with components (incl. time-base switch)
73	3.41	1	5322 216 54132	Delay line unit
74	3.41	1	5322 216 54131	Printed wiring board of vertical amplifier unit, complete with components (incl. att. switches, delay line unit and delay line)
75	3.41	1	5322 216 54109	High tension unit
76	3.41	1	5322 216 54147	C.R.T. adjustment unit
77	3.41	1	5322 216 54148	Storage unit

3.6.1.1. Miscellaneous parts

Item	Ordering number	Description
B1	5322 131 24027	C.R.T. type L14-130 GH/55
LA1	5322 134 40268	Lamp 28 V, 40 mA (Type 387)
LA4	4822 134 40167	Lamp 5 V, 60 mA
VL1	4822 253 30016	Fuse 400 mA delayed action
VL802	4822 253 30024	Fuse, 1,6 A delayed action
T801	5322 146 14081	Mains transformer

3.6.

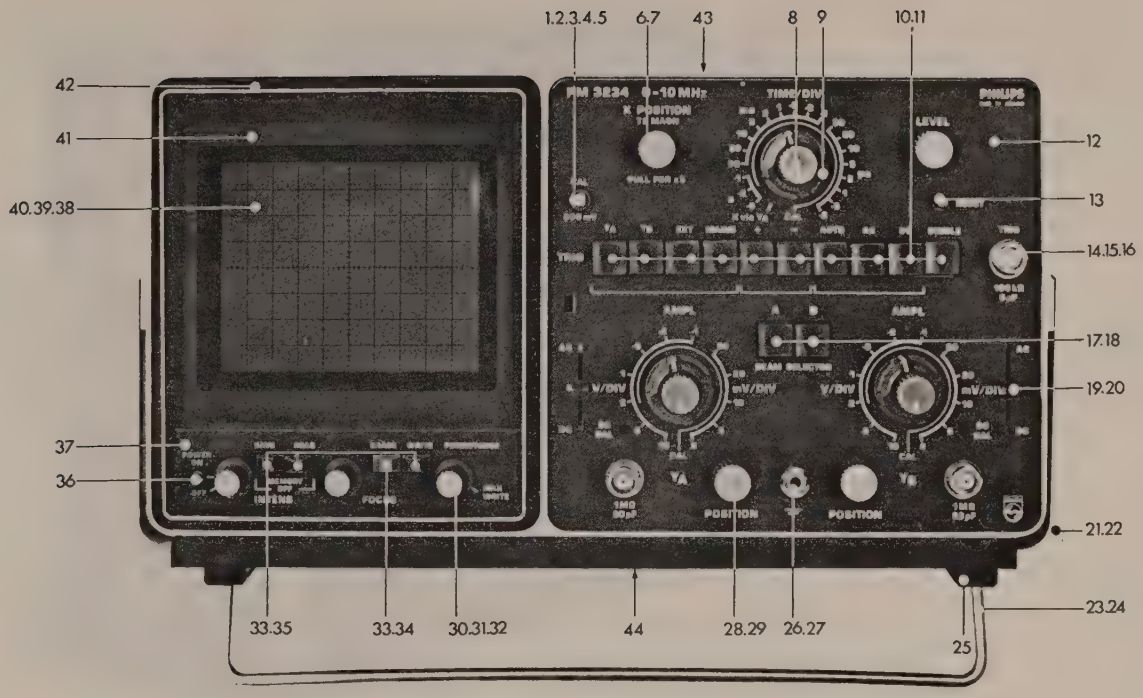
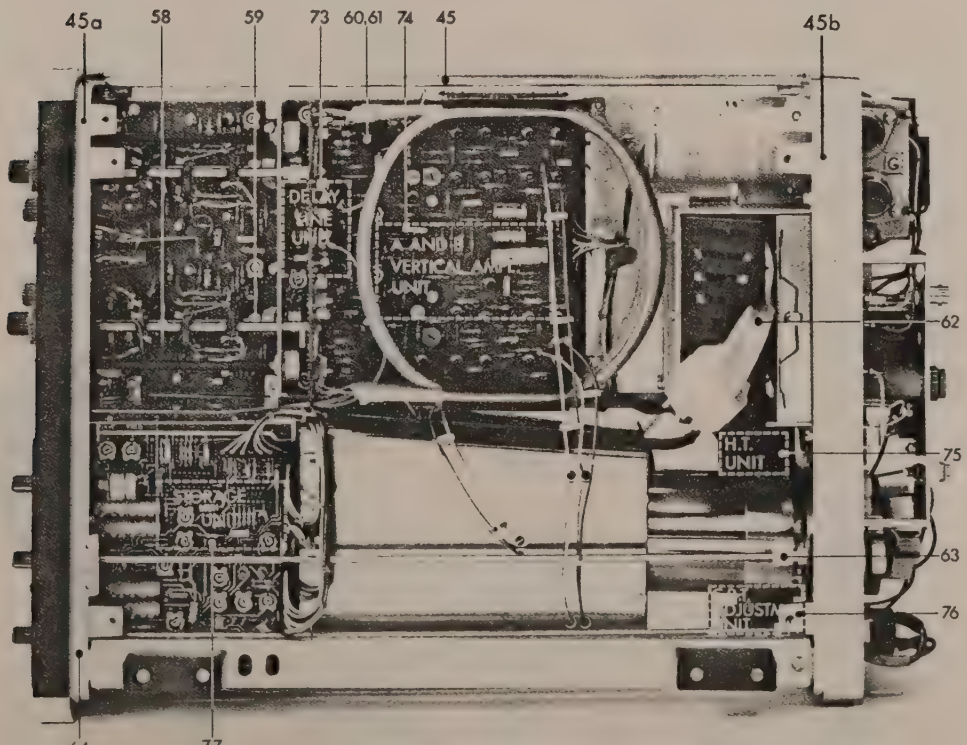


Fig. 3.39. Front view showing item numbers



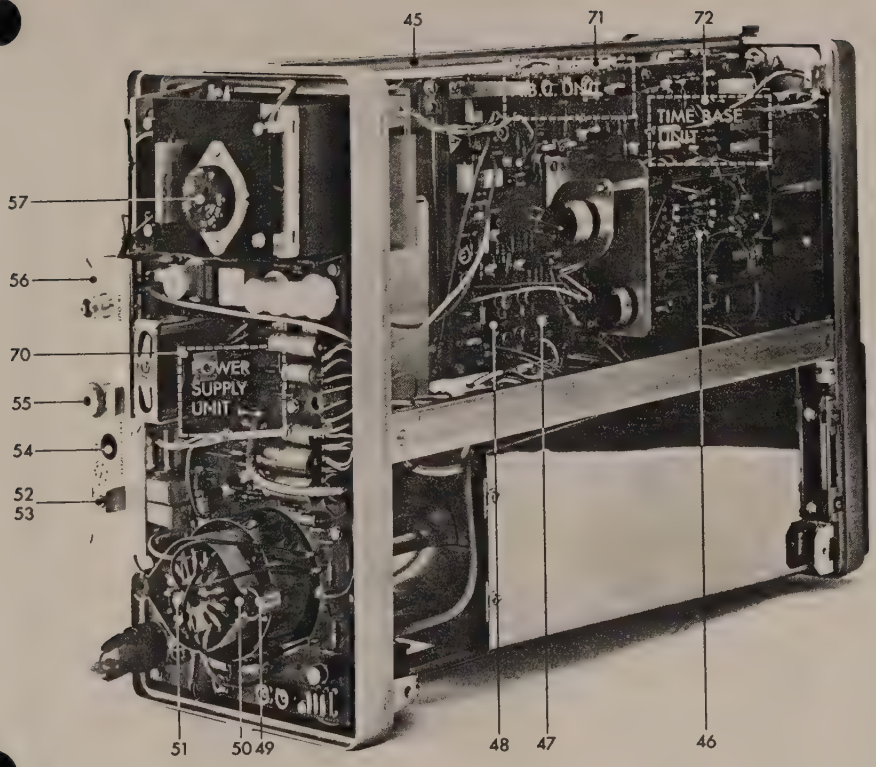
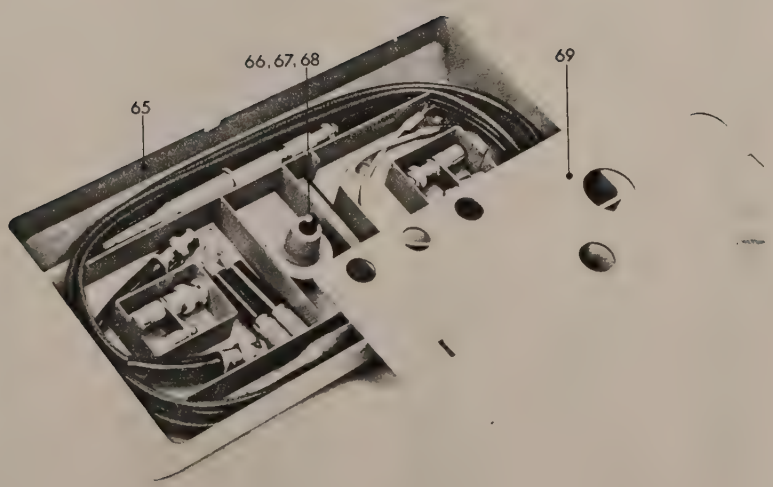


Fig. 3.41. Bottom view showing item numbers



3.6.2. Electrical parts

3.6.2.1. Capacitors

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 26	4822 121 40149	100NF	10	630	POLYESTER FOIL
C 28	5322 125 54027	5,5PF		400	TRIMMER
C 29	5322 125 54027	5,5PF		400	TRIMMER
C 30	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 31	4822 122 31202	33PF	2	500	CERAMIC PLATE
C 32	4822 122 31187	2,7PF	0,25PF	500	CERAMIC PLATE
C 33	5322 125 54027	5,5PF		400	TRIMMER
C 34	5322 125 54027	5,5PF		400	TRIMMER
C 35	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 36	5322 121 54128	390PF	5	250	POLYSTYRENE FOIL
C 37	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 38	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 50	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 51	5322 121 54086	82PF	1	500	POLYSTYRENE FOIL
C 52	5322 125 54027	5,5PF		400	TRIMMER
C 53	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 54	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 55	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 56	4822 122 31172	180PF	10	100	CERAMIC PLATE
C 57	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 58	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 59	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 60	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 61	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 62	4822 125 50045	22PF		100	TRIMMER
C 63	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 64	4822 122 31178	680PF	10	100	CERAMIC PLATE
C 66	4822 122 31178	680PF	10	100	CERAMIC PLATE
C 67	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 68	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 69	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 73	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 74	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 76	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 77	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 78	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 79	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 80	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 81	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 82	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 83	4822 121 40104	150NF	10	250	POLYESTER FOIL
C 84	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 226	4822 121 40149	100NF	10	630	POLYESTER FOIL
C 228	5322 125 54027	5,5PF		400	TRIMMER
C 229	5322 125 54027	5,5PF		400	TRIMMER
C 230	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 231	4822 122 31202	33PF	2	500	CERAMIC PLATE
C 232	4822 122 31187	2,7PF	0,25PF	500	CERAMIC PLATE
C 233	5322 125 54027	5,5PF		400	TRIMMER
C 234	5322 125 54027	5,5PF		400	TRIMMER
C 235	5322 125 54027	5,5PF		400	TRIMMER
C 236	5322 121 54128	390PF	5	250	POLYSTYRENE FOIL
C 237	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 238	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 250	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 251	5322 121 54086	82PF	1	500	POLYSTYRENE FOIL
C 252	5322 125 54027	5,5PF		400	TRIMMER
C 253	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 256	4822 122 31172	180PF	10	100	CERAMIC PLATE
C 257	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 258	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 259	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 261	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 262	4822 125 50045	22PF		100	TRIMMER
C 263	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 264	4822 122 31178	680PF	10	100	CERAMIC PLATE
C 266	4822 122 31178	680PF	10	100	CERAMIC PLATE
C 267	4822 122 31072	47PF	2	100	CERAMIC PLATE

C 273	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 274	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 276	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 277	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 278	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 279	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 281	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 282	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 283	4822 124 20527	470UF	-10+50	25	ELECTROLYTIC
C 284	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 285	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 286	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 400	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 401	4822 120 11027	1PF	0,25PF	500	CERAMIC
C 402	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 403	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 404	4822 122 30114	2,2NF	10	100	CERAMIC PLATE
C 405	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 406	5322 121 40197	1UF	10	100	POLYESTER FOIL
C 407	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 408	4822 121 40186	470NF	10	250	POLYESTER FOIL
C 409	4822 121 40186	470NF	10	250	POLYESTER FOIL
C 410	4822 124 20466	4,7UF	-10+50	16	ELECTROLYTIC
C 411	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 415	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 416	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 417	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 501	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 502	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 503	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 504	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 505	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 506	4822 124 20466	4,7UF	-10+50	16	ELECTROLYTIC
C 507	4822 122 31166	560PF	10	100	CERAMIC PLATE
C 508	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 509	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 510	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 511	4822 122 31221	1,5NF	10	100	CERAMIC PLATE
C 512	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 513	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 514	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 516	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 521	4822 121 40266	4,7UF	10	100	POLYESTER FOIL
C 522	5322 121 54055	510PF	1	250	POLYSTYRENE FOIL
C 523	4822 121 50543	5,6NF	1	63	POLYSTYRENE FOIL
C 524	4822 124 20584	2,2UF	-10+50	63	ELECTROLYTIC
C 526	4822 121 50566	1NF	5	125	POLYSTYRENE FOIL
C 601	4822 122 31172	180PF	2	100	CERAMIC PLATE
C 602	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 603	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 604	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 606	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 607	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 608	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 609	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 702	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 703	4822 121 41138	15NF	10	250	POLYESTER FOIL
C 704	4822 121 40104	150NF	10	250	POLYESTER FOIL
C 706	4822 121 40253	1NF	10	1600	POLYESTER FOIL
C 707	4822 121 40253	1NF	10	1600	POLYESTER FOIL
C 708	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 709	4822 121 40253	1NF	10	1600	POLYESTER FOIL
C 750	4822 121 40411	33NF	10	250	POLYESTER FOIL
C 751	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 752	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 753	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 754	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 756	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 801	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 802	4822 121 41134	10NF	10	630	POLYESTER FOIL

ITEM	ORDERING NO. DEL	VALUE	TOL (%)	VOLTS	DESCRIPTION
C 804	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 805	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 806	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 807	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 808	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 809	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 810	5322 121 44167	100NF	20	250	POLYESTER FOIL
C 811	5322 121 40197	1UF	10	100	POLYESTER FOIL
C 812	5322 121 40197	1UF	10	100	POLYESTER FOIL
C 813	4822 124 20492	1 5UF		63	ELECTROLYTIC
C 814	4822 124 20492	1,5UF		63	ELECTROLYTIC
C 815	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 816	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 817	4822 124 70315	6800UF	-10+50	40	ELECTROLYTIC
C 818	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 819	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 820	4822 121 41134	10NF	10	630	POLYESTER FOIL
C 821	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 822	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 823	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 825	4822 124 20462	100UF	-10+50	10	ELECTROLYTIC
C 826	4822 121 40196	22NF	10	1600	POLYESTER FOIL
C 827	4822 121 40196	22NF	10	1600	POLYESTER FOIL
C 828	4822 124 20313	10UF	-10+30	200	ELECTROLYTIC
C 829	4822 124 20305	32UF	-10+30	100	ELECTROLYTIC
C 830	4822 124 20485	33UF	-10+50	40	ELECTROLYTIC
C 831	4822 124 20527	470UF	-10+50	25	ELECTROLYTIC
C 832	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 833	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 834	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 836	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 837	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 838	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 839	5322 122 24001	600PF	20	9K	CERAMIC TUBULAR
C 841	4822 124 20518	1000UF	-10+50	10	ELECTROLYTIC
C 842	4822 124 20518	1000UF	-10+50	10	ELECTROLYTIC
C 901	4822 125 50045	22PF		100	TRIMMER
C 902	4822 125 50045	22PF		100	TRIMMER
C 903	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 904	4822 121 41134	10NF		250	POLYESTER FOIL
C 906	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 907	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 908	4822 121 40239	47NF		250	POLYESTER FOIL
C 1001	4822 125 50045	22PF		100	TRIMMER
C 1002	4822 125 50045	22PF		100	TRIMMER
C 1003	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 1004	4822 121 41134	10NF		250	POLYESTER FOIL
C 1006	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 1007	4822 120 11054	10PF	5	500	CERAMIC
C 1010	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 1011	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1012	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 1013	5322 121 40197	1UF	10	100	POLYESTER FOIL
C 1014	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1015	4822 124 20582	47UF	-10+50	4	ELECTROLYTIC
C 1016	4822 121 40257	330NF	10	100	POLYESTER FOIL
C 1017	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1018	4822 122 31165	330PF	10	500	CERAMIC PLATE
C 1019	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1020	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1021	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 1022	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 1023	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1024	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 1025	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 1026	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1027	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 1028	4822 124 20605	1,5UF	-10+50	63	ELECTROLYTIC
C 1029	4822 124 20452	33UF	-10+50	6,3	ELECTROLYTIC

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1	5322 101 64003	2,2K	20	0.25W	CARBON POTM LIN + SWITCH
R 2	5322 101 44005	10K	20	0.25W	CARBON POTM LIN + SWITCH
R 3	4822 102 30177	2x47K	20	0,1W	CARBON TANDEM POTM
R 4	4822 101 20455	1K	20	0,1W	CARBON POTM LIN
R 5	4822 101 20455	1K	20	0,1W	CARBON POTM LIN
R 6	4822 101 20417	22K	20	0,1W	CARBON POTM LIN
R 7	4822 101 20417	22K	20	0,1W	CARBON POTM LIN
R 8	4822 101 40061	22K	20	0.25W	CARBON POTM LIN + SWITCH
R 9	5322 101 24032	470K+4K7		0,25W	CARBON POTM LIN
R 10	5322 101 44018	10K	20	0.25W	CARBON POTM LIN + SWITCH
R 11	5322 101 24045	1K	20	0.25W	CARBON POTM LIN
R 12	5322 101 24045	1K	20	0.25W	CARBON POTM LIN
R 26	4822 110 63072	47	5	CR25	CARBON
R 27	5322 116 54212	900K	1	MR30	METAL FILM
R 28	4822 110 63072	47	5	CR25	CARBON
R 29	5322 116 54213	111K	1	MR30	METAL FILM
R 32	5322 116 54209	992K	1	MR30	METAL FILM
R 33	5322 116 54211	10,1K	1	MR30	METAL FILM
R 36	5322 116 54858	156	0,25	MR34C	METAL FILM
R 37	5322 116 54273	437	0,25	MR34C	METAL FILM
R 38	5322 116 50486	1,11K	0,25	MR34C	METAL FILM
R 39	5322 116 50385	4,75K	0,25	MR34C	METAL FILM
R 40	5322 116 50289	348	0,25	MR34C	METAL FILM
R 41	5322 116 54274	898	0,25	MR34C	METAL FILM
R 42	5322 116 54275	1,89K	0,25	MR34C	METAL FILM
R 43	5322 116 54276	17,2K	0,25	MR34C	METAL FILM
R 44	5322 116 50552	4,27K	0,25	MR34C	METAL FILM
R 51	5322 116 54749	90,9K	1	MR30	METAL FILM
R 52	5322 116 54408	909K	1	MR30	METAL FILM
R 53	4822 110 63072	47	5	CR25	CARBON
R 54	4822 110 63072	47	5	CR25	CARBON
R 56	4822 110 63072	47	5	CR25	CARBON
R 57	4822 110 63103	680	5	CR25	CARBON
R 58	4822 110 63127	5,6K	5	CR25	CARBON
R 59	4822 110 63072	47	5	CR25	CARBON
R 60	4822 110 63129	6,8K	5	CR25	CARBON
R 61	4822 110 63132	8,2K	5	CR25	CARBON
R 62	5322 116 54277	4,93K	0,25	MR34C	METAL FILM
R 63	4822 110 63094	330	5	CR25	CARBON
R 64	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 65	4822 110 63056	12	5	CR25	CARBON
R 66	4822 110 60077	75	5	CR25	CARBON
R 67	4822 110 63132	8,2K	5	CR25	CARBON
R 68	5322 116 34011	33	10	0.5W	NTC
R 69	4822 110 63081	100	5	CR25	CARBON
R 71	4822 110 63134	10K	5	CR25	CARBON
R 72	4822 110 63134	10K	5	CR25	CARBON
R 73	4822 110 63085	150	5	CR25	CARBON
R 74	4822 110 60115	2K	5	CR25	CARBON
R 75	4822 110 63121	3,3K	5	CR25	CARBON
R 76	4822 110 63161	100K	5	CR25	CARBON
R 77	4822 110 63072	47	5	CR25	CARBON
R 78	4822 110 63116	2,2K	5	CR25	CARBON
R 81	4822 110 53129	6,8K	5	CR37	CARBON
R 82	4822 110 53129	6,8K	5	CR37	CARBON
R 83	4822 110 63094	330	5	CR25	CARBON
R 84	4822 110 53127	5,6K	5	CR37	CARBON
R 85	4822 116 20063				VDR
R 86	4822 110 63083	120	5	CR25	CARBON
R 87	4822 110 53127	5,6K	5	CR37	CARBON
R 88	4822 110 63127	5,6K	5	CR25	CARBON
R 89	4822 110 63103	680	5	CR25	CARBON
R 91	4822 110 63089	220	5	CR25	CARBON
R 92	4822 110 63121	3,3K	5	CR25	CARBON
R 93	4822 110 60115	2K	5	CR25	CARBON
R 94	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 95	4822 110 63081	100	5	CR25	CARBON
R 96	4822 110 60131	7,5K	5	CR25	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 97	5322 116 54855	5,36K	1	MR30	METAL FILM
R 98	4822 110 63072	47	5	CR25	CARBON
R 99	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 100	4822 110 63081	100	5	CR25	CARBON
R 101	5322 116 54595	5,11K	1	MR25	METAL FILM
R 102	5322 116 54255	17,4K	0,25	MR34C	METAL FILM
R 103	4822 110 60099	510	5	CR25	CARBON
R 104	4822 110 63107	1K	5	CR25	CARBON
R 106	4822 110 53072	47	5	CR37	CARBON
R 107	5322 116 54587	3,65K	1	MR25	METAL FILM
R 108	4822 110 63096	390	5	CR25	CARBON
R 109	5322 116 54587	3,65K	1	MR25	METAL FILM
R 111	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 112	4822 110 63089	220	5	CR25	CARBON
R 114	4822 110 63152	47K	5	CR25	CARBON
R 116	4822 110 63107	1K	5	CR25	CARBON
R 117	4822 110 63152	47K	5	CR25	CARBON
R 118	4822 110 63096	390	5	CR25	CARBON
R 119	4822 110 63107	1K	5	CR25	CARBON
R 121	4822 110 63134	10K	5	CR25	CARBON
R 122	4822 110 42214	10M	5	VR37	CARBON
R 123	4822 110 42207	5,6M	5	VR37	CARBON
R 124	4822 110 63132	8,2K	5	CR25	CARBON
R 125	4822 110 63116	2,2K	5	CR25	CARBON
R 126	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 127	4822 110 42214	10M	5	VR37	CARBON
R 128	5322 116 54408	909K	1	MR30	METAL FILM
R 129	4822 110 42214	10M	5	VR37	CARBON
R 130	4822 110 63141	18K	5	CR25	CARBON
R 131	4822 110 60179	510K	5	CR25	CARBON
R 132	4822 110 53127	5,6K	5	CR37	CARBON
R 133	4822 110 53127	5,6K	5	CR37	CARBON
R 134	4822 110 63083	120	5	CR25	CARBON
R 135	4822 116 20063				VDR
R 136	4822 110 63094	330	5	CR25	CARBON
R 137	4822 110 53129	6,8K	5	CR37	CARBON
R 138	4822 110 53129	6,8K	5	CR37	CARBON
R 142	4822 110 63054	10	5	CR25	CARBON
R 143	4822 110 63043	3,9	5	R25	CARBON
R 144	4822 110 63103	680	5	CR25	CARBON
R 145	4822 110 63072	47	5	CR25	CARBON
R 146	4822 110 63103	680	5	CR25	CARBON
R 147	4822 110 63103	680	5	CR25	CARBON
R 226	4822 110 63072	47	5	CR25	CARBON
R 227	5322 116 54212	900K	1	MR30	METAL FILM
R 228	4822 110 63072	47	5	CR25	CARBON
R 229	5322 116 54213	111K	1	MR30	METAL FILM
R 232	5322 116 54209	992K	1	MR30	METAL FILM
R 233	5322 116 54211	10,1K	1	MR30	METAL FILM
R 236	5322 116 54858	156	0,25	MR34C	METAL FILM
R 237	5322 116 54273	437	0,25	MR34C	METAL FILM
R 238	5322 116 50486	1,11K	0,25	MR34C	METAL FILM
R 239	5322 116 50385	4,75K	0,25	MR34C	METAL FILM
R 240	5322 116 50289	348	0,25	MR34C	METAL FILM
R 241	5322 116 54274	898	0,25	MR34C	METAL FILM
R 242	5322 116 54275	1,89K	0,25	MR34C	METAL FILM
R 243	5322 116 54276	17,2K	0,25	MR34C	METAL FILM
R 244	5322 116 50552	4,27K	0,25	MR34C	METAL FILM
R 251	5322 116 54749	90,9K	1	MR30	METAL FILM
R 252	5322 116 54408	909K	1	MR30	METAL FILM
R 253	4822 110 63072	47	5	CR25	CARBON
R 254	4822 110 63072	47	5	CR25	CARBON
R 256	4822 110 63072	47	5	CR25	CARBON
R 257	4822 110 63103	680	5	CR25	CARBON
R 258	4822 110 63127	5,6K	5	CR25	CARBON
R 259	4822 110 63072	47	5	CR25	CARBON
R 261	4822 110 63132	8,2K	5	CR25	CARBON
R 262	5322 116 54277	4,93K	0,25	MR34C	METAL FILM
R 263	4822 110 63094	330	5	CR25	CARBON
R 264	4822 100 10038	470	20	0.05W	TRIMMING POTM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 265	4822 110 63056	12	5	CR25	CARBON
R 266	4822 110 60077	75	5	CR25	CARBON
R 267	4822 110 63132	8,2K	5	CR25	CARBON
R 268	5322 116 34011	33	10	0,5W	NTC
R 272	4822 110 63116	2,2K	5	CR25	CARBON
R 276	4822 110 63161	100K	5	CR25	CARBON
R 277	4822 110 63072	47	5	CR25	CARBON
R 278	4822 110 60115	2K	5	CR25	CARBON
R 280	4822 110 63085	150	5	CR25	CARBON
R 281	4822 110 53129	6,8K	5	CR37	CARBON
R 282	4822 110 53129	6,8K	5	CR37	CARBON
R 283	4822 110 60093	300	5	CR25	CARBON
R 284	4822 110 53127	5,6K	5	CR37	CARBON
R 285	4822 116 20063				VDR
R 286	4822 110 63083	120	5	CR25	CARBON
R 287	4822 110 53127	5,6K	5	CR37	CARBON
R 288	4822 110 63127	5,6K	5	CR25	CARBON
R 289	4822 110 63103	680	5	CR25	CARBON
R 291	4822 110 63089	220	5	CR25	CARBON
R 292	4822 110 63121	3,3K	5	CR25	CARBON
R 293	4822 110 60115	2K	5	CR25	CARBON
R 294	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 295	4822 110 63069	39	5	CR25	CARBON
R 296	4822 110 60131	7,5K	5	CR25	CARBON
R 297	5322 116 54855	5,36K	1	MR30	METAL FILM
R 298	4822 110 63072	47	5	CR25	CARBON
R 299	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 300	4822 110 63081	100	5	CR25	CARBON
R 301	5322 116 54595	5,11K	1	MR25	METAL FILM
R 302	5322 116 54255	17,4K	0,25	MR34C	METAL FILM
R 303	4822 110 60099	510	5	CR25	CARBON
R 306	4822 110 63072	47	5	CR25	CARBON
R 307	5322 116 54587	3,65K	1	MR25	METAL FILM
R 308	4822 110 63096	390	5	CR25	CARBON
R 309	5322 116 54587	3,65K	1	MR25	METAL FILM
R 311	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 312	4822 110 63089	220	5	CR25	CARBON
R 314	4822 110 63152	47K	5	CR25	CARBON
R 316	4822 110 63107	1K	5	CR25	CARBON
R 317	4822 110 63152	47K	5	CR25	CARBON
R 318	4822 110 63096	390	5	CR25	CARBON
R 319	4822 110 63107	1K	5	CR25	CARBON
R 321	4822 110 63134	10K	5	CR25	CARBON
R 322	4822 110 42214	10M	5	VR37	CARBON
R 323	4822 110 42207	5,6M	5	VR37	CARBON
R 324	4822 110 63132	8,2K	5	CR25	CARBON
R 326	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 327	4822 110 42214	10M	5	VR37	CARBON
R 328	5322 116 54408	909K	1	MR30	METAL FILM
R 329	4822 110 42214	10M	5	VR37	CARBON
R 331	4822 110 60179	510K	5	CR25	CARBON
R 332	4822 110 53127	5,6K	5	CR37	CARBON
R 333	4822 110 53127	5,6K	5	CR37	CARBON
R 334	4822 110 63083	120	5	CR25	CARBON
R 335	4822 116 20063				VDR
R 336	4822 110 60093	300	5	CR25	CARBON
R 337	4822 110 53129	6,8K	5	CR37	CARBON
R 338	4822 110 53129	6,8K	5	CR37	CARBON
R 339	4822 110 63043	3,9	5	R25	CARBON
R 341	4822 110 63081	100	5	CR25	CARBON
R 342	4822 110 63054	10	5	CR25	CARBON
R 345	4822 110 63072	47	5	CR25	CARBON
R 346	4822 110 63103	680	5	CR25	CARBON
R 400	4822 110 63196	2,2M	10	CR25	CARBON
R 401	5322 116 54749	91K	5	CR37	METAL FILM
R 402	4822 110 63134	10K	5	CR25	CARBON
R 403	5322 116 54595	5,11K	1	MR25	METAL FILM
R 404	5322 116 54603	6,49K	1	MR25	METAL FILM
R 405	4822 110 63072	47	5	CR25	CARBON
R 406	4822 110 63098	470	5	CR25	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 407	4822 110 63098	470	5	CR25	CARBON
R 408	4822 110 63132	8,2K	5	CR25	CARBON
R 409	4822 110 60124	4,3K	5	CR25	CARBON
R 410	4822 110 63134	10K	5	CR25	CARBON
R 411	4822 110 63125	4,7K	5	CR25	CARBON
R 412	4822 110 60117	2,4K	5	CR25	CARBON
R 413	4822 110 60108	1,1K	5	CR25	CARBON
R 414	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 415	4822 110 63116	2,2K	5	CR25	CARBON
R 416	4822 110 63098	470	5	CR25	CARBON
R 418	4822 110 60142	20K	5	CR25	CARBON
R 419	4822 110 63072	47	5	CR25	CARBON
R 420	4822 110 63072	47	5	CR25	CARBON
R 421	4822 110 63081	100	5	CR25	CARBON
R 422	4822 110 63081	100	5	CR25	CARBON
R 423	4822 110 63109	1,2K	5	CR25	CARBON
R 424	4822 100 10029	2,2K	20	0,05W	TRIMMING POTM
R 426	4822 110 63105	820	5	CR25	CARBON
R 427	4822 110 63072	47	5	CR25	CARBON
R 428	4822 110 63145	27K	5	CR25	CARBON
R 429	4822 110 63107	1K	5	CR25	CARBON
R 431	4822 110 63072	47	5	CR25	CARBON
R 432	4822 110 63152	47K	5	CR25	CARBON
R 433	4822 110 63143	22K	5	CR25	CARBON
R 434	4822 110 63125	4,7K	5	CR25	CARBON
R 436	4822 110 63143	22K	5	CR25	CARBON
R 440	4822 110 63027	1	5	CR25	CARBON
R 443	4822 110 63072	47	5	CR25	CARBON
R 447	4822 110 63114	1,8K	5	CR25	CARBON
R 448	4822 110 60097	430	5	CR25	CARBON
R 449	4822 110 63072	47	5	CR25	CARBON
R 501	5322 116 54426	121	1	MR25	METAL FILM
R 502	5322 116 54005	3,32K	1	MR25	METAL FILM
R 503	4822 110 60086	160	5	CR25	CARBON
R 504	4822 110 63072	47	5	CR25	CARBON
R 506	5322 116 54557	1,21K	1	MR25	METAL FILM
R 507	5322 116 54619	10K	1	MR25	METAL FILM
R 508	4822 110 60091	240	5	CR25	CARBON
R 509	5322 116 54534	681	1	MR25	METAL FILM
R 511	5322 116 50608	6,19K	1	MR25	METAL FILM
R 512	4822 110 63109	1,2K	5	CR25	CARBON
R 513	4822 110 63121	3,3K	5	CR25	CARBON
R 514	4822 110 63107	1K	5	CR25	CARBON
R 516	5322 116 50524	3,01K	1	MR25	METAL FILM
R 517	5322 116 54627	13,3K	1	MR25	METAL FILM
R 518	4822 110 63129	6,8K	5	CR25	CARBON
R 519	4822 110 63156	68K	5	CR25	CARBON
R 521	4822 110 63116	2,2K	5	CR25	CARBON
R 522	4822 110 63081	100	5	CR25	CARBON
R 524	4822 110 63116	2,2K	5	CR25	CARBON
R 526	4822 110 63098	470	5	CR25	CARBON
R 527	4822 110 63134	10K	5	CR25	CARBON
R 528	4822 110 60157	75K	5	CR25	CARBON
R 529	4822 110 63094	330	5	CR25	CARBON
R 530	4822 110 63072	47	5	CR25	CARBON
R 531	4822 110 63103	680	5	CR25	CARBON
R 532	4822 116 30018	1,3K	20	1W	NTC
R 533	4822 110 63121	3,3K	5	CR25	CARBON
R 534	4822 100 10029	2,2K	20	0,05W	TRIMMING POTM
R 536	4822 110 60126	5,1K	5	CR25	CARBON
R 537	4822 110 63132	8,2K	5	CR25	CARBON
R 538	4822 110 60128	6,2K	5	CR25	CARBON
R 539	4822 100 10051	22K	20	0,05W	TRIMMING POTM
R 541	4822 110 63072	47	5	CR25	CARBON
R 542	4822 110 63081	100	5	CR25	CARBON
R 543	4822 110 63087	180	5	CR25	CARBON
R 544	4822 110 63081	100	5	CR25	CARBON
R 547	4822 110 63101	560	5	CR25	CARBON
R 549	4822 110 63094	330	5	CR25	CARBON
R 551	4822 110 63134	10K	5	CR25	CARBON

R 552	4822 110 63129	6,8K	5	CR25	CARBON
R 553	4822 100 10037	1K	20	0,05W	TRIMMING POTM
R 554	4822 110 63136	12K	5	CR25	CARBON
R 556	4822 110 63072	47	5	CR25	CARBON
R 557	4822 110 63107	1K	5	CR25	CARBON
R 558	4822 110 53107	1K	5	CR37	CARBON
R 559	4822 110 63125	4,7K	5	CR25	CARBON
R 561	4822 110 63063	22	5	CR25	CARBON
R 562	4822 110 63063	22	5	CR25	CARBON
R 563	4822 110 63063	22	5	CR25	CARBON
R 565	4822 110 63107	1K	5	CR25	CARBON
R 566	5322 116 54278	576K	1	MR30	METAL FILM
R 567	5322 116 54729	226K	1	MR25	METAL FILM
R 568	5322 116 54279	115K	1	MR25	METAL FILM
R 569	5322 116 54676	56,2K	1	MR25	METAL FILM
R 570	4822 110 63072	47	5	CR25	CARBON
R 571	5322 116 50481	22,6K	1	MR25	METAL FILM
R 572	5322 116 50668	11,3K	1	MR25	METAL FILM
R 573	5322 116 54011	5,62K	1	MR25	METAL FILM
R 574	5322 116 54574	2,21K	1	MR25	METAL FILM
R 576	5322 116 54554	1,1K	1	MR25	METAL FILM
P 601	4822 100 10037	1K	20	0,05W	TRIMMING POTM
R 602	4822 110 63112	1,5K	5	CR25	CARBON
R 603	4822 110 63081	100	5	CR25	CARBON
R 604	4822 110 60119	3K	5	CR25	CARBON
R 606	4822 110 63132	8,2K	5	CR25	CARBON
R 607	4822 110 63136	12K	5	CR25	CARBON
R 609	4822 110 63156	68K	5	CR25	CARBON
R 610	4822 110 63116	2,2K	5	CR25	CARBON
R 611	4822 110 63072	47	5	CR25	CARBON
R 612	4822 110 60106	910	5	CR25	CARBON
R 613	4822 110 63127	5,6K	5	CR25	CARBON
R 614	4822 110 63114	1,8K	5	CR25	CARBON
R 615	4822 110 60119	3K	5	CR25	CARBON
R 616	4822 110 63072	47	5	CR25	CARBON
R 617	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 618	4822 100 10035	10K	20	0,05W	TRIMMING POTM
R 619	4822 110 63156	68K	5	CR25	CARBON
R 621	4822 110 63125	4,7K	5	CR25	CARBON
R 622	4822 110 63129	6,8K	5	CR25	CARBON
R 623	4822 110 63125	4,7K	5	CR25	CARBON
R 624	4822 110 63114	1,8K	5	CR25	CARBON
R 626	4822 110 63134	10K	5	CR25	CARBON
R 627	4822 110 53152	47K	5	CR37	CARBON
R 628	4822 110 53152	47K	5	CR37	CARBON
R 629	4822 116 20063				VDR
R 631	4822 110 63105	820	5	CR25	CARBON
R 632	4822 110 63063	22	5	CR25	CARBON
R 633	4822 110 53152	47K	5	CR37	CARBON
R 634	4822 116 20063				VDR
R 636	4822 110 63105	820	5	CR25	CARBON
R 637	4822 110 53152	47K	5	CR37	CARBON
R 638	4822 110 63072	47	5	CR25	CARBON
R 639	4822 110 63072	47	5	CR25	CARBON
R 701	4822 110 63134	10K	5	CR25	CARBON
R 704	4822 110 63072	47	5	CR25	CARBON
R 705	4822 110 63072	47	5	CR25	CARBON
R 706	4822 110 60113	1,6K	5	CR25	CARBON
R 707	4822 110 63098	470	5	CR25	CARBON
R 708	4822 110 63134	10K	5	CR25	CARBON
R 709	4822 110 63156	68K	5	CR25	CARBON
R 710	4822 110 63107	1K	5	CR25	CARBON
R 711	4822 100 10029	2,2K	20	0,05W	TRIMMING POTM
R 712	4822 110 60108	1,1K	5	CR25	CARBON
R 713	4822 110 63187	1M	5	CR25	CARBON
R 714	4822 110 63187	1M	5	CR25	CARBON
R 715	4822 110 63081	100	5	CR25	CARBON
R 716	4822 110 63125	4,7K	5	CR25	CARBON
R 717	4822 110 63147	33K	5	CR25	CARBON
R 718	4822 110 60162	110K	5	CR25	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 719	4822 110 63156	68K	5	CR25	CARBON
R 720	4822 110 63158	82K	5	CR25	CARBON
R 721	4822 116 20063				VDR
R 722	4822 110 63094	330	5	CR25	CARBON
R 750	4822 110 63116	2,2K	5	CR25	CARBON
R 751	4822 110 63123	3,9K	5	CR25	CARBON
R 752	4822 110 63114	1,8K	5	CR25	CARBON
R 753	4822 110 63132	8,2K	5	CR25	CARBON
R 754	4822 110 63185	820K	5	CR25	CARBON
R 756	4822 110 63101	560	5	CR25	CARBON
R 757	4822 110 63123	3,9K	5	CR25	CARBON
R 758	4822 110 63092	270	5	CR25	CARBON
R 759	5322 116 54623	11K	1	MR25	METAL FILM
R 761	4822 100 10037	1K	20	0.05W	TRIMMING POTM
R 762	5322 116 54554	1,1K	1	MR25	METAL FILM
R 763	4822 110 63072	47	5	CR25	CARBON
R 764	4822 110 63072	47	5	CR25	CARBON
R 800	4822 110 63169	220K	5	CR25	CARBON
R 801	4822 100 10089	1M	20	0.05W	TRIMMING POTM
R 802	4822 110 63107	1K	5	CR25	CARBON
R 803	4822 110 42194	1,8M	10	CR68	CARBON
R 805	4822 110 60157	75K	5	CR25	CARBON
R 806	4822 110 63178	470K	5	CR25	CARBON
R 807	4822 110 42192	1,5M	10	CR68	CARBON
R 809	4822 100 10107	470K	20	0.05W	TRIMMING POTM
R 810	4822 110 53185	820K	5	CR37	CARBON
R 811	4822 110 63161	100K	5	CR25	CARBON
R 812	4822 100 10107	470K	20	0.05W	TRIMMING POTM
R 813	5322 101 24115	22K	20	0.1W	CARBON POTM LIN
R 815	4822 110 63027	1	5	CR25	CARBON
R 817	4822 110 63143	22K	5	CR25	CARBON
R 818	4822 110 63096	390	5	CR25	CARBON
R 819	4822 110 63121	3,3K	5	CR25	CARBON
R 820	4822 110 63101	560	5	CR25	CARBON
R 821	4822 110 63152	47K	5	CR25	CARBON
R 822	4822 110 63105	820	5	CR25	CARBON
R 823	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 824	4822 110 63105	820	5	CR25	CARBON
R 825	4822 110 63098	470	5	CR25	CARBON
R 826	4822 110 63114	1,8K	5	CR25	CARBON
R 827	4822 110 63054	10	5	CR25	CARBON
R 828	5322 116 64015	7,5M	5	VR68	METAL OXIDE
R 829	4822 110 60144	24K	5	CR25	CARBON
R 830	4822 110 63134	10K	5	CR25	CARBON
R 831	4822 110 63098	470	5	CR25	CARBON
R 832	4822 110 60115	2K	5	CR25	CARBON
R 833	5322 116 54005	3,32K	1	MR25	METAL FILM
R 834	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 836	5322 116 54005	3,32K	1	MR25	METAL FILM
R 837	5322 116 54005	3,32K	1	MR25	METAL FILM
R 838	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 839	5322 116 54005	3,32K	1	MR25	METAL FILM
R 841	5322 116 54696	100K	1	MR25	METAL FILM
R 842	5322 116 50672	51,1K	1	MR25	METAL FILM
R 843	4822 110 63169	220K	5	CR25	CARBON
R 844	5322 116 54469	100	1	MR25	METAL FILM
R 846	5322 116 54469	100	1	MR25	METAL FILM
R 847	4822 100 10036	4,7K	20	0.05W	TRIMMING POTM
R 848	4822 100 10089	1M	20	0.05W	TRIMMING POTM
R 849	4822 100 10089	1M	20	0.05W	TRIMMING POTM
R 851	5322 116 64053	12M	5	VR68	METAL OXIDE
R 852	4822 110 42187	1M	5	VR37	CARBON
R 853	5322 116 54619	10K	1	MR25	METAL FILM
R 854	5322 116 54619	10K	1	MR25	METAL FILM
R 856	5322 116 54518	383	1	MR25	METAL FILM
R 857	5322 116 54518	383	1	MR25	METAL FILM
R 859	5322 116 50559	27,4K	1	MR25	METAL FILM
R 901	4822 110 63187	1M	5	CR25	CARBON
R 902	4822 110 63105	820	5	CR25	CARBON
R 903	5322 116 54519	402	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 904	5322 116 50555	1,27K	1	MR25	METAL FILM
R 906	4822 110 63072	47	5	CR25	CARBON
R 908	4822 110 63105	820	5	CR25	CARBON
R 909	4822 110 63098	470	5	CR25	CARBON
R 911	5322 116 54541	825	1	MR25	METAL FILM
R 912	4822 110 60122	3,6K	5	CR25	CARBON
R 913	4822 110 60093	300	5	CR25	CARBON
R 914	4822 110 60137	13K	5	CR25	CARBON
R 916	5322 116 54484	140	1	MR25	METAL FILM
R 917	5322 116 54484	140	1	MR25	METAL FILM
R 918	5322 116 54587	3,65K	1	MR25	METAL FILM
R 919	4822 110 63072	47	5	CR25	CARBON
R 920	5322 116 54515	348	1	MR25	METAL FILM
R 921	4822 110 63123	3,9K	5	CR25	CARBON
R 922	4822 110 63109	1,2K	5	CR25	CARBON
R 923	5322 116 54585	3,48K	1	MR25	METAL FILM
R 924	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1001	4822 110 63187	1M	5	CR25	CARBON
R 1002	4822 110 63105	820	5	CR25	CARBON
R 1003	5322 116 54519	402	1	MR25	METAL FILM
R 1004	5322 116 50555	1,27K	1	MR25	METAL FILM
R 1006	4822 110 63072	47	5	CR25	CARBON
R 1008	4822 110 63105	820	5	CR25	CARBON
R 1009	4822 110 63098	470	5	CR25	CARBON
R 1011	5322 116 54541	825	1	MR25	METAL FILM
R 1012	4822 110 60122	3,6K	5	CR25	CARBON
R 1013	4822 110 60093	300	5	CR25	CARBON
R 1014	4822 110 60137	13K	5	CR25	CARBON
R 1016	5322 116 54484	140	1	MR25	METAL FILM
R 1017	5322 116 54484	140	1	MR25	METAL FILM
R 1018	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1019	4822 110 63072	47	5	CR25	CARBON
R 1020	5322 116 54515	348	1	MR25	METAL FILM
R 1021	4822 110 63123	3,9K	5	CR25	CARBON
R 1022	4822 110 63109	1,2K	5	CR25	CARBON
R 1023	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1024	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1031	4822 100 10036	4,7K	20	0,05W	TRIMMING POTM
R 1032	4822 110 60146	30K	5	CR25	CARBON
R 1033	4822 110 63196	2,2M	10	CR25	CARBON
R 1034	5322 116 54632	14,7K	1	MR25	METAL FILM
R 1035	4822 110 63081	100	5	CR25	CARBON
R 1036	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1037	4822 110 63125	4,7K	5	CR25	CARBON
R 1038	4822 110 63134	10K	5	CR25	CARBON
R 1039	5322 110 60173	300K	5	CR25	CARBON
R 1041	4822 110 60184	750K	5	CR25	CARBON
R 1042	4822 110 63134	10K	5	CR25	CARBON
R 1043	4822 110 63098	470	5	CR25	CARBON
R 1044	4822 100 10035	10K	20	0,05W	TRIMMING POTM
R 1045	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1046	4822 100 10036	4,7K	20	0,05W	TRIMMING POTM
R 1047	4822 110 63136	12K	5	CR25	CARBON
R 1048	5322 116 54736	261K	1	MR25	METAL FILM
R 1049	4822 100 10088	220K	20	0,05W	TRIMMING POTM
R 1050	4822 110 63178	470K	5	CR25	CARBON
R 1051	4822 110 63145	27K	5	CR25	CARBON
R 1052	4822 110 63161	100K	5	CR25	CARBON
R 1053	4822 110 63125	4,7K	5	CR25	CARBON
R 1054	5322 116 54696	100K	1	MR25	METAL FILM
R 1055	4822 110 63161	100K	5	CR25	CARBON
R 1056	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1057	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1058	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1059	4822 100 10029	2,2K	20	0,05W	TRIMMING POTM
R 1060	4822 110 63161	100K	5	CR25	CARBON
R 1061	4822 110 63187	1M	5	CR25	CARBON
R 1062	5322 116 50729	4,22K	1	MR25	METAL FILM
R 1063	5322 116 54549	1K	1	MR25	METAL FILM
R 1064	5322 116 54519	402	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1066	4822 110 63161	100K	5	CR25	CARBON
R 1067	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1068	4822 100 10035	10K	20	0,05W	TRIMMING POTM
R 1069	4822 110 63152	47K	5	CR25	CARBON
R 1071	4822 110 63098	470	5	CR25	CARBON
R 1072	4822 110 63134	10K	5	CR25	CARBON
R 1073	5322 110 60173	300K	5	CR25	CARBON
R 1074	4822 110 60184	750K	5	CR25	CARBON
R 1076	4822 110 63134	10K	5	CR25	CARBON
R 1077	4822 110 63125	4,7K	5	CR25	CARBON
R 1078	4822 110 63125	4,7K	5	CR25	CARBON
R 1081	4822 110 63114	1,8K	5	CR25	CARBON
R 1082	4822 110 63114	1,8K	5	CR25	CARBON
R 1083	4822 100 10079	47K	20	0,05W	TRIMMING POTM
R 1084	4822 100 10036	4,7K	20	0,05W	TRIMMING POTM
R 1086	4822 110 63152	47K	5	CR25	CARBON
R 1087	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1088	4822 110 63158	82K	5	CR25	CARBON
R 1089	5322 116 54674	53,6K	1	MR25	METAL FILM
R 1091	4822 110 63163	120K	5	CR25	CARBON
R 1092	4822 110 63156	68K	5	CR25	CARBON
R 1093	5322 116 54619	10K	1	MR25	METAL FILM
R 1094	5322 116 54629	14K	1	MR25	METAL FILM
R 1095	4822 110 63096	390	5	CR25	CARBON
R 1096	4822 110 63072	47	5	CR25	CARBON
R 1097	4822 110 63125	4,7K	5	CR25	CARBON
R 1098	4822 110 60108	1,1K	5	CR25	CARBON
R 1099	4822 110 63125	4,7K	5	CR25	CARBON
R 1101	4822 110 63161	100K	5	CR25	CARBON
R 1102	4822 110 63125	4,7K	5	CR25	CARBON
R 1103	4822 110 63125	4,7K	5	CR25	CARBON
R 1104	4822 110 63125	4,7K	5	CR25	CARBON
R 1105	4822 110 63107	1K	5	CR25	CARBON
R 1106	4822 110 63112	1,5K	5	CR25	CARBON
R 1107	4822 110 63132	8,2K	5	CR25	CARBON
R 1108	4822 110 60122	3,6K	5	CR25	CARBON
R 1109	4822 110 63125	4,7K	5	CR25	CARBON
R 1110	4822 110 63134	10K	5	CR25	CARBON
R 1111	4822 110 63125	4,7K	5	CR25	CARBON
R 1113	4822 110 63125	4,7K	5	CR25	CARBON
R 1114	4822 110 63132	8,2K	5	CR25	CARBON
R 1116	4822 110 63121	3,3K	5	CR25	CARBON
R 1117	4822 110 63187	1M	5	CR25	CARBON
R 1118	4822 110 63125	4,7K	5	CR25	CARBON
R 1119	4822 110 63125	4,7K	5	CR25	CARBON
R 1121	4822 110 63125	4,7K	5	CR25	CARBON
R 1122	4822 110 53081	100	5	CR37	CARBON
R 1123	4822 110 63152	47K	5	CR25	CARBON
R 1124	4822 110 63156	68K	5	CR25	CARBON
R 1131	4822 110 63125	4,7K	5	CR25	CARBON
R 1132	4822 110 63125	4,7K	5	CR25	CARBON
R 1133	4822 110 60108	1,1K	5	CR25	CARBON
R 1134	4822 110 63152	47K	5	CR25	CARBON
R 1136	4822 110 63161	100K	5	CR25	CARBON
R 1137	4822 110 63143	22K	5	CR25	CARBON
R 1138	4822 100 10025	4,7K	20	0,05W	TRIMMING POTM
R 1139	5322 110 60173	300K	5	CR25	CARBON

3.6.2.3. Diodes

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
GR53	5322 130 34037	BAV45
GR54	5322 130 34173	BZX79-C5V6
GR56	5322 130 30766	BZX79-C6V2
GR57	5322 130 30766	BZX79-C6V2
GR58	5322 130 30766	BZX79-C6V2
GR253	5322 130 34037	BAV45
GR254	5322 130 34173	BZX79-C5V6
GR257	5322 130 30766	BZX79-C6V2
GR401	5322 130 40182	BAX13
GR402	5322 130 40182	BAX13

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
GR403	5322 130 34173	BZX79-C5V6
GR404	5322 130 30231	AAZ13
GR406	5322 130 30231	AAZ13
GR408	5322 130 34197	BZX79-C12
GR409	5322 130 40182	BAX13
GR500	5322 130 40182	BAX13
GR501	5322 130 30231	AAZ13
GR502	5322 130 40182	BAX13
GR503	5322 130 40182	BAX13
GR504	5322 130 40182	BAX13
GR506	5322 130 30273	BAX16
GR702	5322 130 30273	BAX16
GR703	5322 130 40182	BAX13
GR751	5322 130 34167	BZX79-B6V2
GR801	5322 130 44286	BZX79-C18
GR802	5322 130 34173	BZX79-C5V6
GR803	5322 130 30414	BY164
GR808	5322 130 34173	BZX79-C5V6
GR809	5322 130 34049	BZX75-C2V1
GR810	5322 130 30424	BAX12
GR811	5322 130 34173	BZX79-C5V6
GR812	5322 130 30424	BAX12
GR814	5322 130 34619	BY187-05
GR816	5322 130 34619	BY187-05
GR817	5322 130 34619	BY187-05
GR818	4822 130 30839	BY206
GR819	5322 130 30605	BAX17
GR820	4822 130 30839	BY206
GR821	5322 130 30424	BAX12
GR822	5322 130 30424	BAX12
GR823	5322 130 30424	BAX12
GR824	5322 130 30424	BAX12
GR826	5322 130 30424	BAX12
GR827	5322 130 30424	BAX12
GR828	5322 130 30605	BAX17
GR829	4822 130 30839	BY206
GR831	5322 130 34275	BYX71-350R
GR832	5322 130 34619	BY187-05
GR833	5322 130 34619	BY187-05
GR834	5322 130 34275	BYX55/350
GR836	5322 130 34167	BZX79-B6V2
GR837	5322 130 34167	BZX79-B6V2
GR838	5322 130 30613	BAW62
GR839	5322 130 30613	BAW62
GR901	5322 130 34174	BZX79-B4V7
GR902	5322 130 34174	BZX79-B4V7
GR1001	5322 130 34174	BZX79-B4V7
GR1002	5322 130 34174	BZX79-B4V7
GR1011	5322 130 40182	BAX13
GR1012	5322 130 30605	BAX17
GR1013	5322 130 40182	BAX13
GR1014	5322 130 30605	BAX17
GR1015	5322 130 40182	BAX13
GR1016	4822 130 30839	BY206
GR1017	5322 130 40182	BAX13
GR1018	5322 130 34413	BZX61-C16
GR1019	5322 130 40182	BAX13
GR1020	5322 130 40182	BAX13
GR1021	5322 130 30773	BZX79-C4V7
GR1024	5322 130 40182	BAX13
GR1026	5322 130 40182	BAX13
GR1027	5322 130 40182	BAX13
GR1028	5322 130 30613	BAW62
GR1033	5322 130 40182	BAX13
GR1034	5322 130 30773	BZX79-C4V7

3.6.2.4. Transistors

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS51	5322 130 40408	BFW11
TS52	5322 130 44195	BF494
TS53	5322 130 44256	BC557

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS54	5322 130 44154	BF199
TS56	5322 130 44257	BC547
TS57	5322 130 44154	BF199
TS58	5322 130 44154	BF199
TS59	5322 130 44154	BF199
TS61	5322 130 44195	BF494
TS62	5322 130 40408	BFW11
TS63	5322 130 40373	BCY71
TS64	5322 130 40324	BCY70
TS66	4822 130 40964	BC549
TS67	4822 130 40964	BC549
TS68	5322 130 44154	BF199
TS69	5322 130 44154	BF199
TS71	5322 130 40144	BC109C
TS72	5322 130 40144	BC109C
TS73	5322 130 44154	BF199
TS74	5322 130 44154	BF199
TS75	4822 130 40963	BC559
TS76	5322 130 44154	BF199
TS251	5322 130 40408	BFW11
TS252	5322 130 44195	BF494
TS253	5322 130 44256	BC557
TS254	5322 130 44154	BF199
TS257	5322 130 44154	BF199
TS258	5322 130 44154	BF199
TS259	5322 130 44154	BF199
TS261	5322 130 44195	BF494
TS262	5322 130 40408	BFW11
TS263	5322 130 40373	BCY71
TS264	5322 130 40324	BCY70
TS266	4822 130 40964	BC549
TS267	4822 130 40964	BC549
TS268	5322 130 44154	BF199
TS269	5322 130 44154	BF199
TS271	5322 130 40144	BC109C
TS272	5322 130 40144	BC109C
TS273	5322 130 44154	BF199
TS274	5322 130 44154	BF199
TS276	5322 130 44154	BF199
TS400	4822 130 40963	BC559
TS401	4822 130 40963	BC559
TS402	5322 130 44195	BF494
TS403	5322 130 44246	BC549C
TS404	5322 130 44246	BC549C
TS406	4822 130 40964	BC549
TS408	4822 130 40963	BC559
TS501	5322 130 44195	BF494
TS502	5322 130 44195	BF494
TS503	5322 130 44246	BC549C
TS504	5322 130 44246	BC549C
TS506	5322 130 44256	BC557
TS508	5322 130 44257	BC547
TS509	5322 130 40417	BSX20
TS511	4822 130 40963	BC559
TS512	4822 130 40964	BC549
TS513	4822 130 40964	BC549
TS516	5322 130 44257	BC547
TS602	5322 130 44195	BF494
TS603	5322 130 44195	BF494
TS604	5322 130 44195	BF494
TS606	5322 130 44257	BC547
TS607	4822 130 40908	BF336
TS608	4822 130 40908	BF336
TS609	4822 130 40908	BF336
TS611	4822 130 40908	BF336
TS702	5322 130 44256	BC557
TS703	4822 130 40968	BSS38
TS704	5322 130 40308	BF115
TS706	5322 130 40308	BF115
TS750	5322 130 44195	BF494
TS751	5322 130 44195	BF494

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS800	5322 130 44247	BSS68
TS801	4822 130 40908	BF336
TS803	5322 130 44256	BC557
TS804	5322 130 44257	BC547
TS806	5322 130 44235	BD237
TS807	5322 130 44235	BD237
TS808	5322 130 44257	BC547
TS809	5322 130 44256	BC557
TS811	5322 130 44256	BC557
TS812	5322 130 44257	BC547
TS813	5322 130 44256	BC557
TS814	5322 130 44256	BC557
TS816	5322 130 44257	BC547
TS901	5322 130 44246	BC549C
TS902	5322 130 44195	BF494
TS903	5322 130 44195	BF494
TS904	4822 130 40964	BC549
TS905	5322 130 44196	BC548C
TS906	5322 130 44246	BC549C
TS1001	5322 130 44246	BC549C
TS1002	5322 130 44195	BF494
TS1003	5322 130 44195	BF494
TS1004	4822 130 40964	BC549
TS1005	5322 130 44196	BC548C
TS1006	5322 130 44246	BC549C
TS1011	5322 130 44246	BC549C
TS1012	5322 130 44246	BC549C
TS1013	4822 130 40989	BC556
TS1014	4822 130 40908	BF336
TS1015	4822 130 40908	BF336
TS1016	5322 130 44256	BC557
TS1017	5322 130 44256	BC557
TS1018	4822 130 40968	BSS38
TS1019	4822 130 40968	BSS38
TS1021	4822 130 40963	BC559
TS1022	4822 130 40963	BC559
TS1023	5322 130 44257	BC547
TS1024	4822 130 40964	BC549
TS1026	5322 130 44196	BC548C
TS1028	4822 130 40963	BC559
TS1029	4822 130 40968	BSS38
TS1031	4822 130 40968	BSS38

3.6.2.5. Integrated circuits

IC1001	5322 209 84386	TCA220	
IC1002	5322 209 84379	ZH181/4L130	
IC1003	5322 209 84512	N7426A	SC

3.6.2.6. Miscellaneous

L 401	5322 158 10308	
L 800	5322 158 10276	
L 801	5322 156 34009	COIL
L 802	5322 142 64028	TRAFO
L 803	4822 157 50308	CHOKE
L 804	4822 157 50308	CHOKE
L 805	5322 158 10308	COIL
L 806	4822 157 50308	CHOKE

3.6.3. PARTS LIST OF PROBE SETS

3.6.3.1. Parts of attenuator probe sets PM 9326 and PM 9327 (Fig. 3.24)

Item	*Qty*	*Ordering number*	*Description*
1	1	5322 320 10042	Probe cable 2 m for PM 9327
1	1	5322 321 20087	Probe cable 1.15 m for PM 9326
2	1	5322 321 20096	Earth lead 15 cm
3	1	5322 321 20134	Earth lead 30 cm
4	1	5322 266 20015	Measuring probe 1:1 (black)
5	1	5322 268 10029	Test pin
6	1	5322 268 10039	Test hook
7	1	5322 210 70044	Attenuator probe 1:10 (grey)
8	1	5322 264 20016	Test clip
	1	5322 111 20155	Resistor

3.6.3.2. Parts of attenuator probe sets PM 9336 and PM 9336L (Fig. 3.26)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 320 14004	Cable assembly PM 9336 (1,5 m)
1	1	5322 320 14013	Cable assembly PM 9336L (2,5 m)
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 20024	Test hook
4	1	5322 264 20028	Test hook sleeve
5	1	5322 532 60535	Protective cap
6	1	5322 256 94034	Probe holder
7	1	5322 268 14017	Probe tip
8	1	5322 321 20223	Earthing cord
9	1	5322 600 34002	Box

3.6.3.3. Parts of probe set PM 9335 (Fig. 3.28)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 264 20024	Test-hook
2	1	5322 264 20028	Test-hook sleeve
3	1	5322 268 14017	Probe tip
4	1	5322 532 60535	Protective cap
5	1	5322 321 20223	Earth lead
6	1	5322 265 94034	Probe holder
7	1	5322 320 14005	Probe assembly
	1	5322 600 34002	Box

3.6.3.4. Parts of 2 kV probe set PM 9358 (Fig. 3.29.)

Item	*Qty*	*Order number*	*Description*
1	1	5322 320 14004	Calbe assembly
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 24008	Test hook
4	1	5322 264 24009	Test hook sleeve
5	1	5322 462 74001	Protective cap
6	1	5322 462 54075	Insulating cap
7	1	5322 265 94034	Probe holder
8	1	5322 264 24011	Test pin
9	1	5322 321 20223	Earthing cord
	1	5322 600 14004	Box

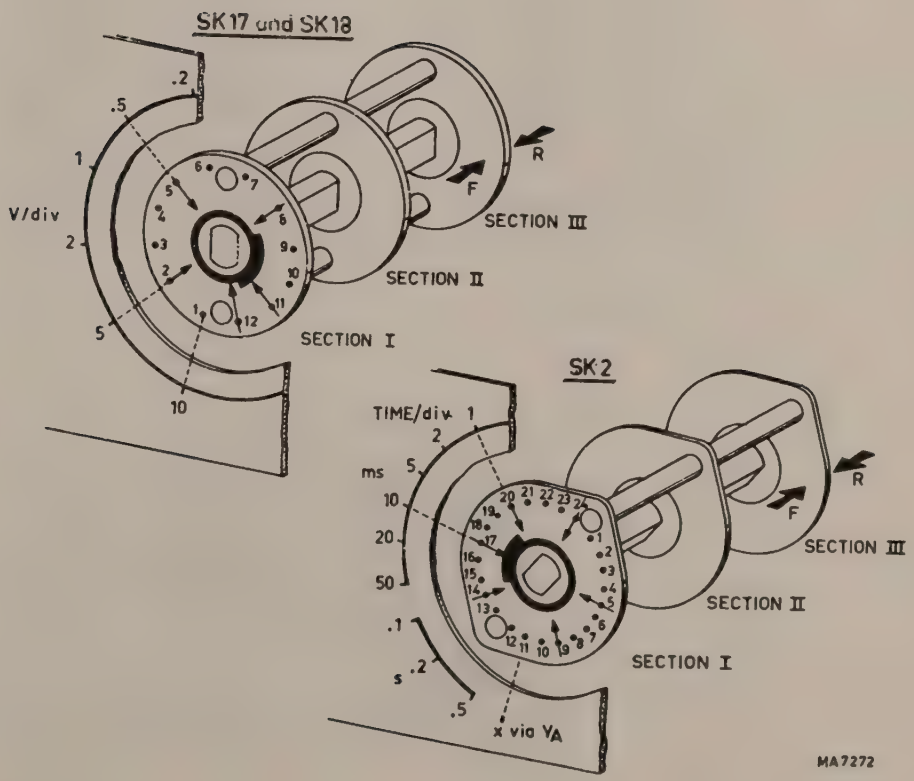


Fig. 3.43. Lay-out of the AMPL and TIME/div switches

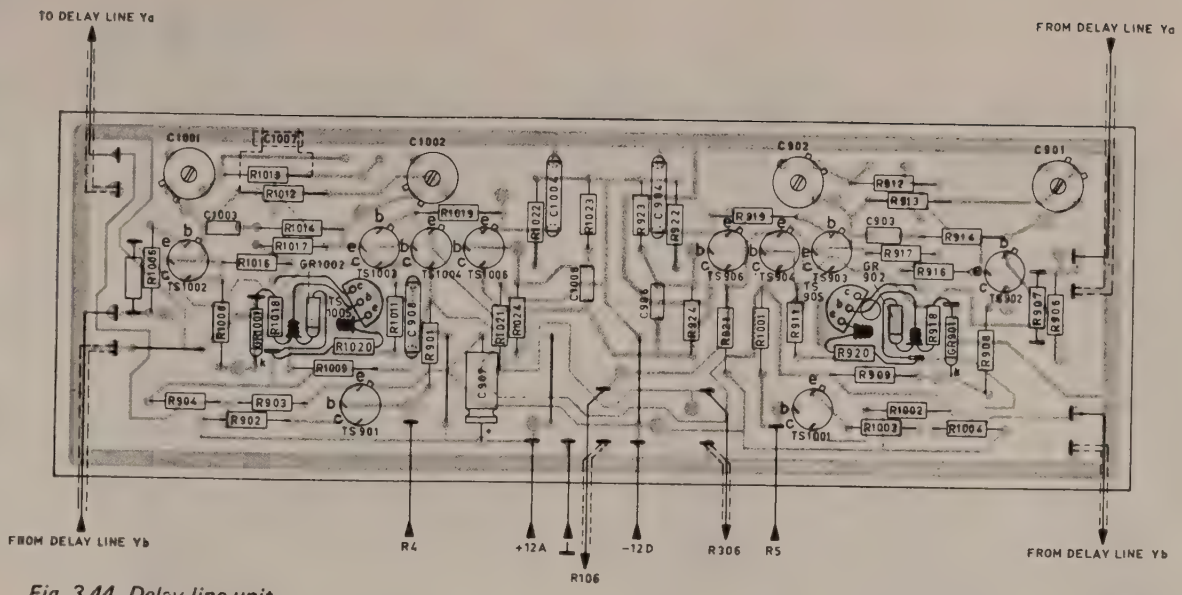


Fig. 3.44. Delay line unit

MA9533

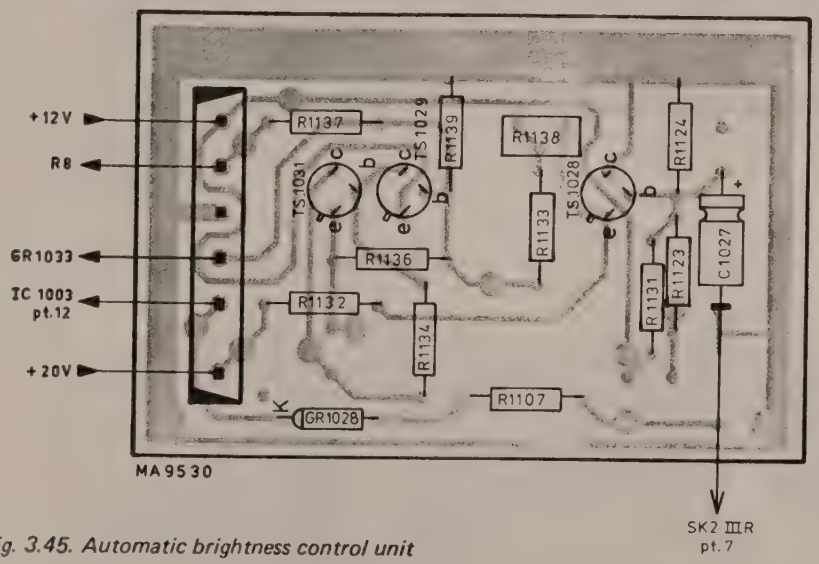


Fig. 3.45. Automatic brightness control unit

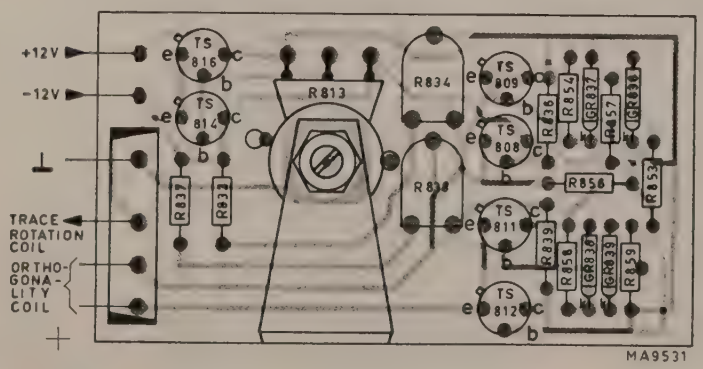


Fig. 3.46. C.R.T. adjustment unit

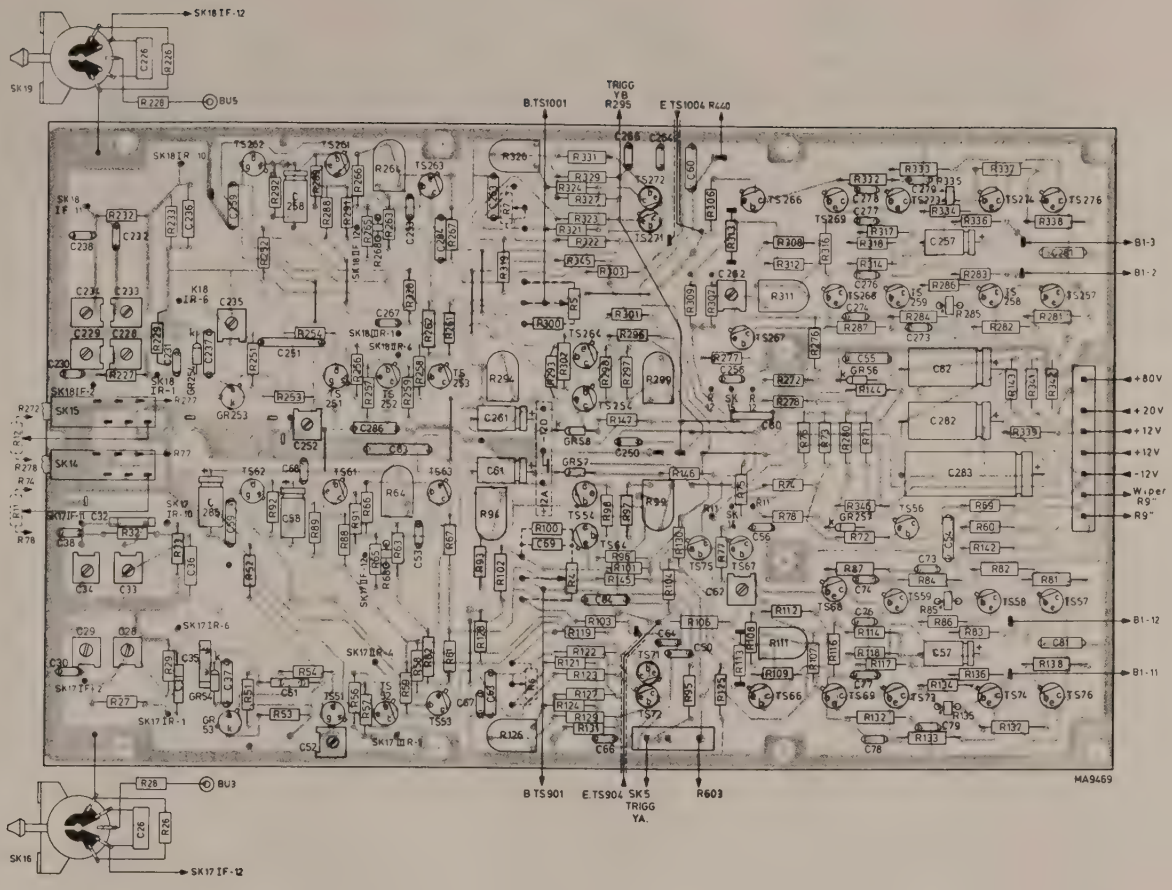


Fig. 3.47. A and B vertical amplifier unit

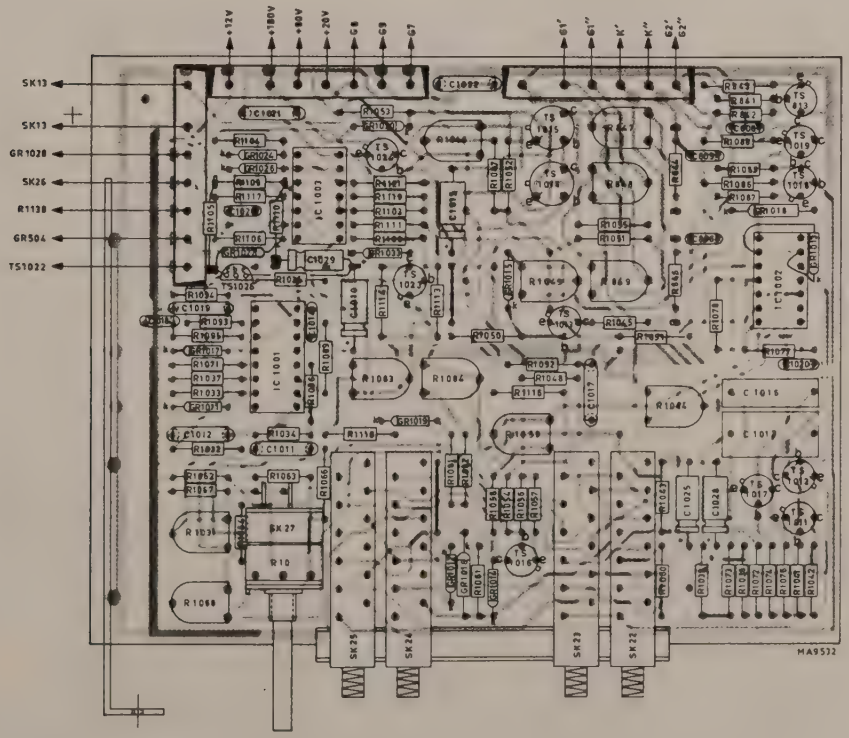


Fig. 3.48. Storage unit

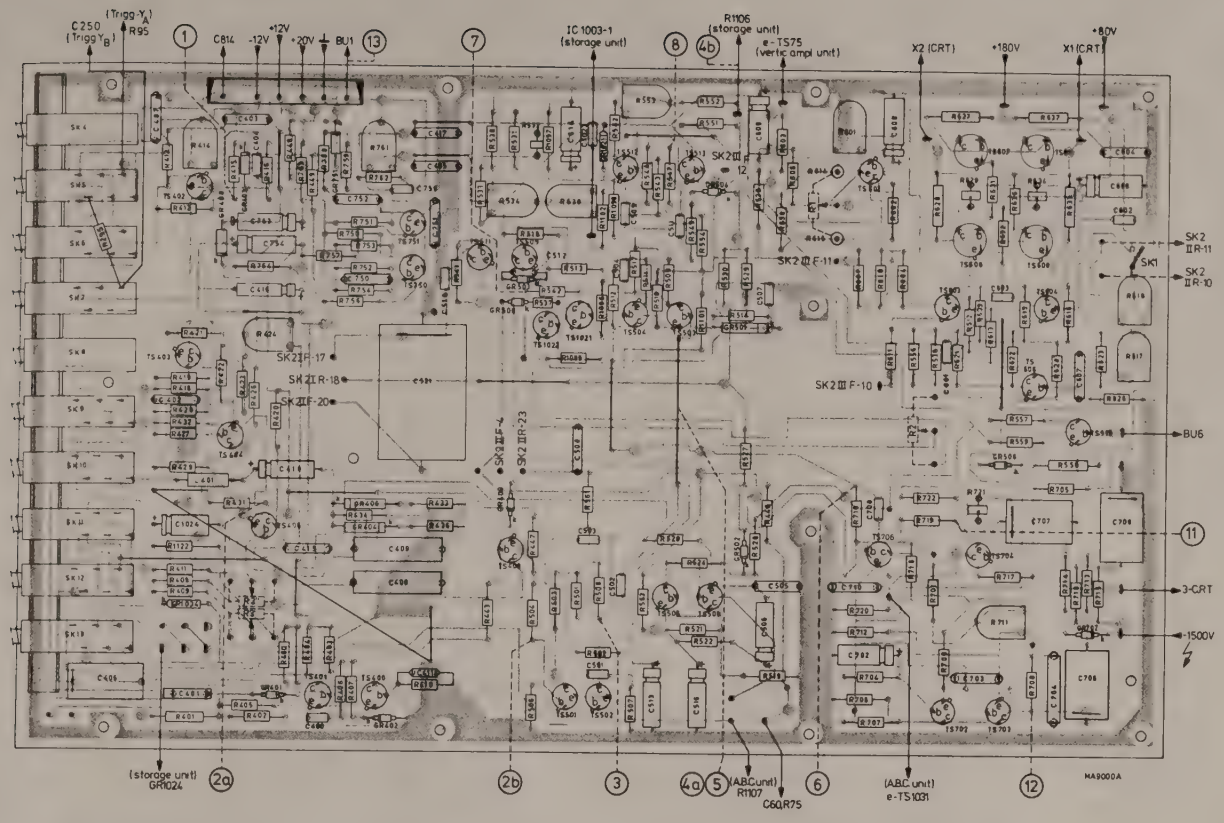


Fig. 3.49. Time-base unit

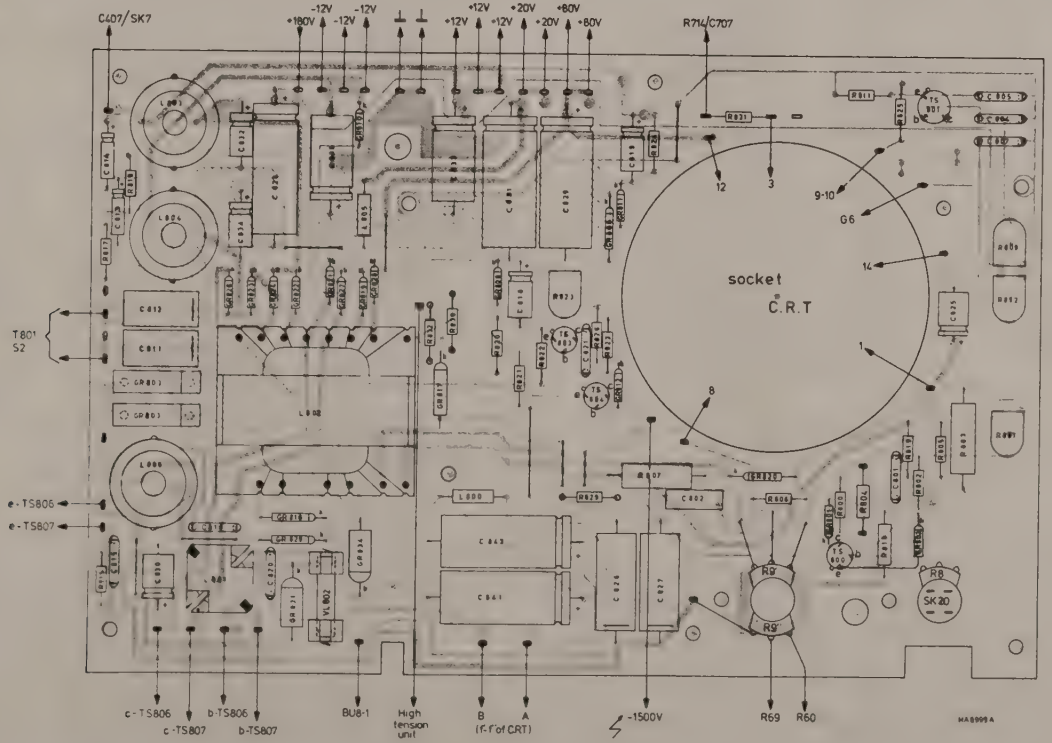
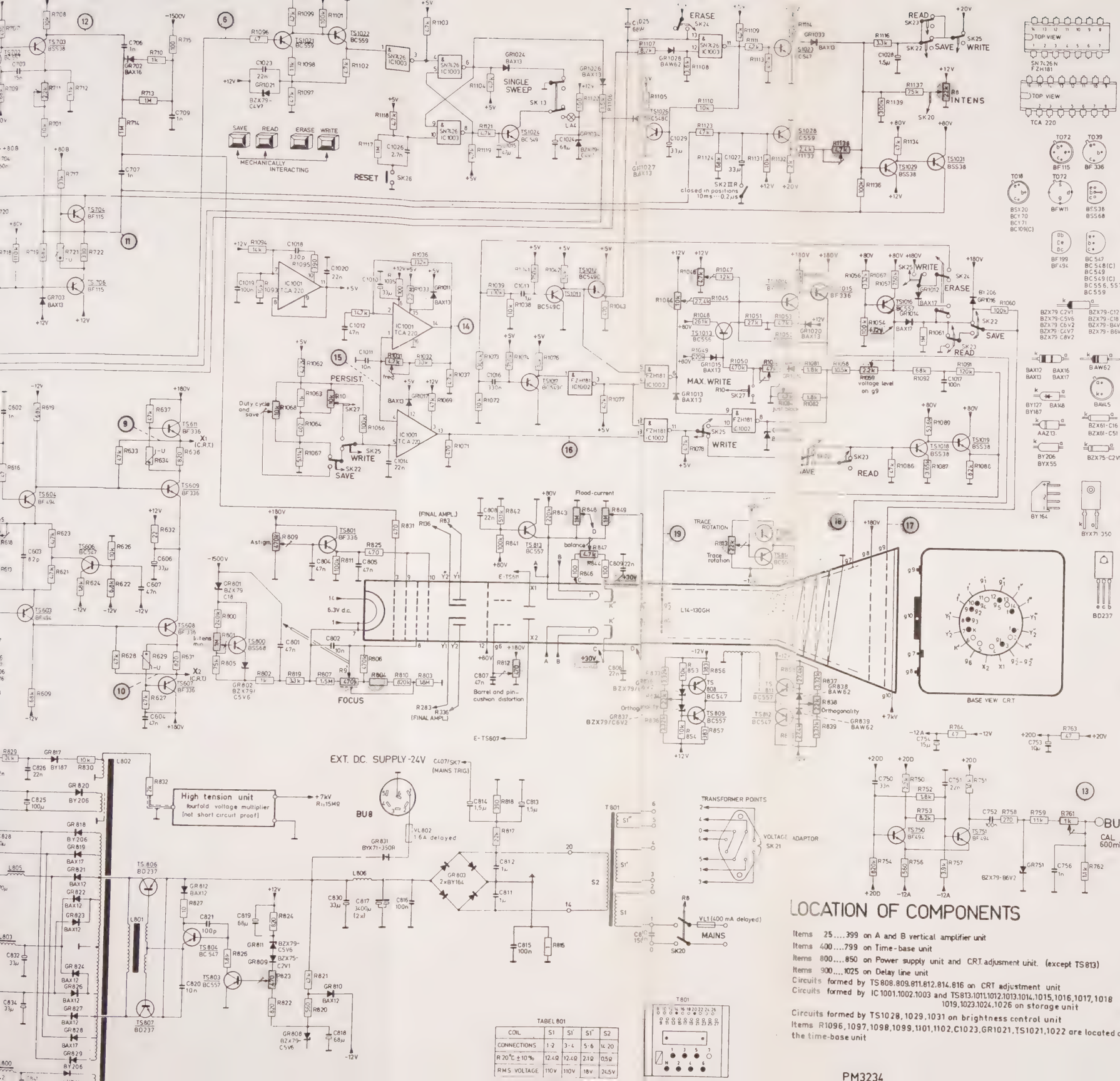


Fig. 3.50. Power supply unit

AMPL. SWITCH Y_A (SK17)

TIME/div SWITCH (SK2)

AMPL. SWITCH Y_B (SK18)



LOCATION OF COMPONENTS

Items 25....399 on A and B vertical amplifier unit
Items 400....799 on Time-base unit
Items 800....850 on Power supply unit and CRT adjustment unit. (except TS813)
Circuits formed by TS808,809,811,812,814,816 on CRT adjustment unit
Circuits formed by IC1001,1002,1003 and TS813,1011,1012,1013,1014,1015,1016,1017,1018 1019,1023,1024,1026 on storage unit
Circuits formed by TS1028, 1029, 1031 on brightness control unit
Items R1096, 1097, 1098, 1099, 1101, 1102, C1023, GR1021, TS1021, 1022 are located on the time-base unit

PM3234

1 — Y=0.2 V/cm X=0.2 ms/cm
Trigger signal (sine-wave) at collector of transistor TS402 PM3234; sine-wave signal 6 V p.p. 2 kHz on Y_A (1 V/cm)
Trigg.-via Y_A in pos. + and auto, Potmeter LEVEL in the middle position
Switch SK25 (WRITE) depressed

2a — Y=2 V/cm X=0.5 ms/cm
a) Output signal of the long-tailed pair circuit (in this case for triggering on the positive slope of the signal)

2b — Y=2 V/cm X=0.5 ms/cm
b) Trigger signal at the input of the trigger-pulse shaper

3 — Y=2 V/cm X=0.5 ms/cm
Trigger signal at the output of the trigger-pulse shaper

4a — Y=0.5 V/cm X=0.5 ms/cm
a) Trigger pulses at the input of the sweep gating multivibrator

4b — Y=0.5 V/cm X=0.5 ms/cm
b) Hold-off signal

5 — Y=0.5 V/cm X=0.5 ms/cm
Signal at the input of the sweep gating multivibrator in the absence of a trigger input signal

6 — Y=2 V/cm X=0.5 ms/cm
Driver pulses for sawtooth generator and blanking circuits

7 — Y=1 V/cm X=0.5 ms/cm
Sawtooth signal

8 — Y=1 V/cm X=0.5 ms/cm
Sawtooth signal at the output of cascade emitter followers circuit

9 — Y=20 V/cm X=0.5 ms/cm
Time-base deflection voltage

10 — Y=20 V/cm X=0.5 ms/cm
Time-base deflection voltage

11 — Y=10 V/cm X=0.5 ms/cm
Blanking pulses
R8 (INTENS) fully clockwise

12 — Y=10 V/cm X=0.5 ms/cm
Modulated signal of blanking pulses and oscillator signal
R8 (INTENS) fully clockwise

13 — Y=0.1 V/cm X=0.2 ms/cm
Calibration signal

14 — Y=1 V/cm X=0.2 ms/cm
Square wave generator (≈2 kHz)

15 — Y=1 V/cm X=0.2 ms/cm
Trainqular wave voltage (≈2kHz) on point 4 of I.C. 1001

16 — Y=1 V/cm X=0.2 ms/cm
R10 (Persistence) counter-clockwise
Switch SK25 (WRITE) depressed
Square wave pulses (≈2kHz) duty cycle variable

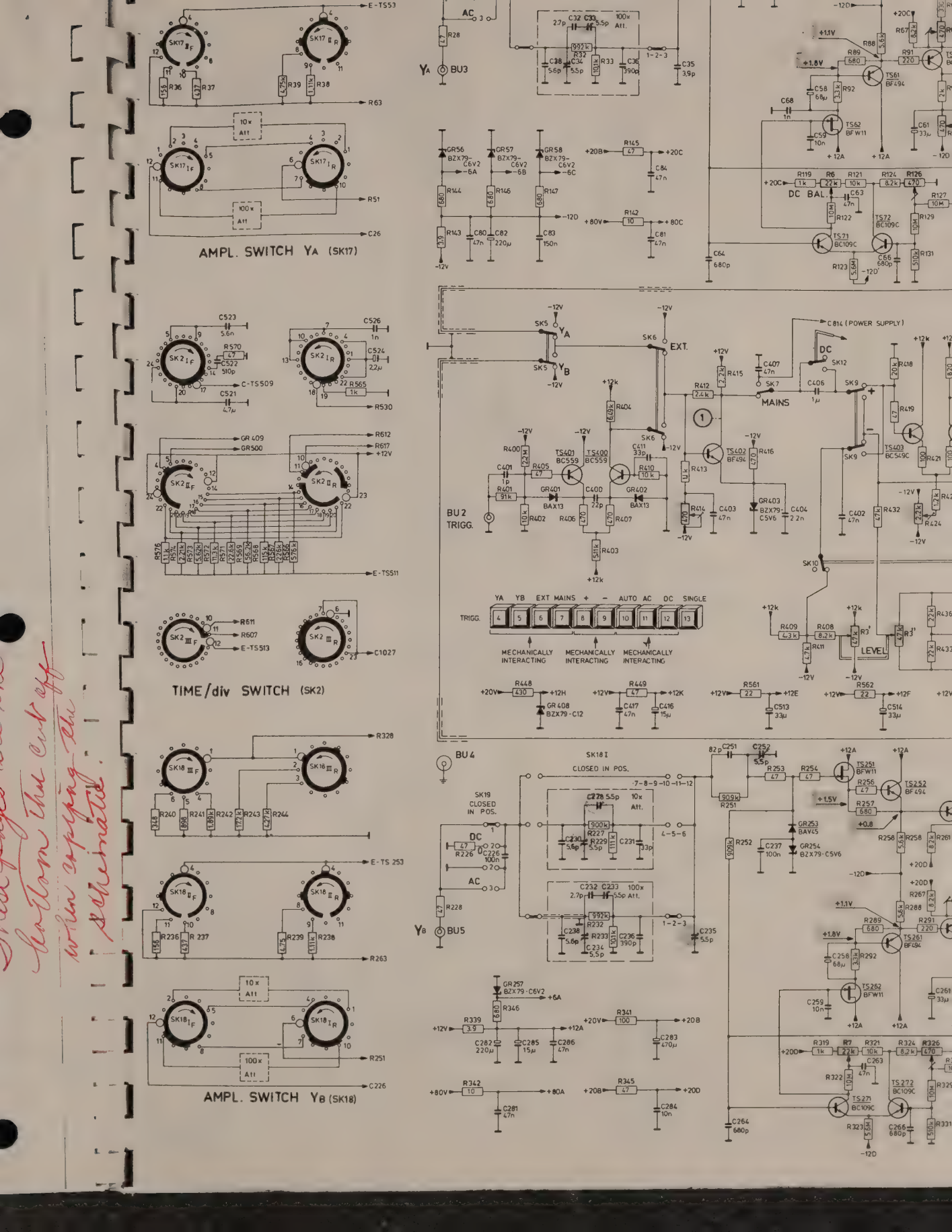
17a — 180V, R1084 Just black, Volt level R1059
Y=10 V/cm X=0.2 s/cm
R10 (Persistence) clockwise
Operation time of SK24 (ERASE)
Storage mesh potential (g9)

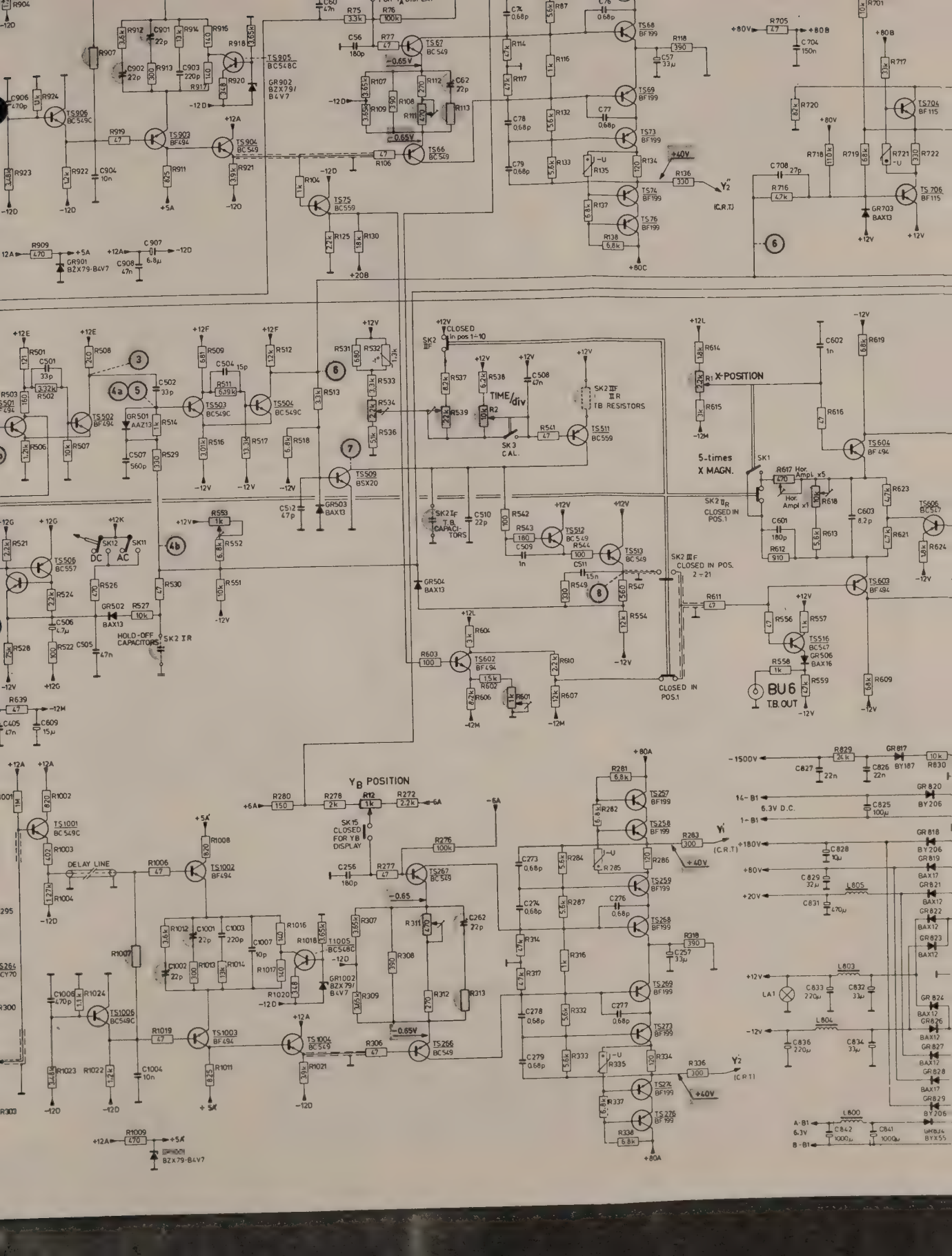
17b — Y=10 V/cm X=0.2 s/cm
R10 (Persistence) counter clockwise
Operation time of SK24 (ERASE) | 2 kHz Pulses of fig 17c
Storage mesh potential (g9)

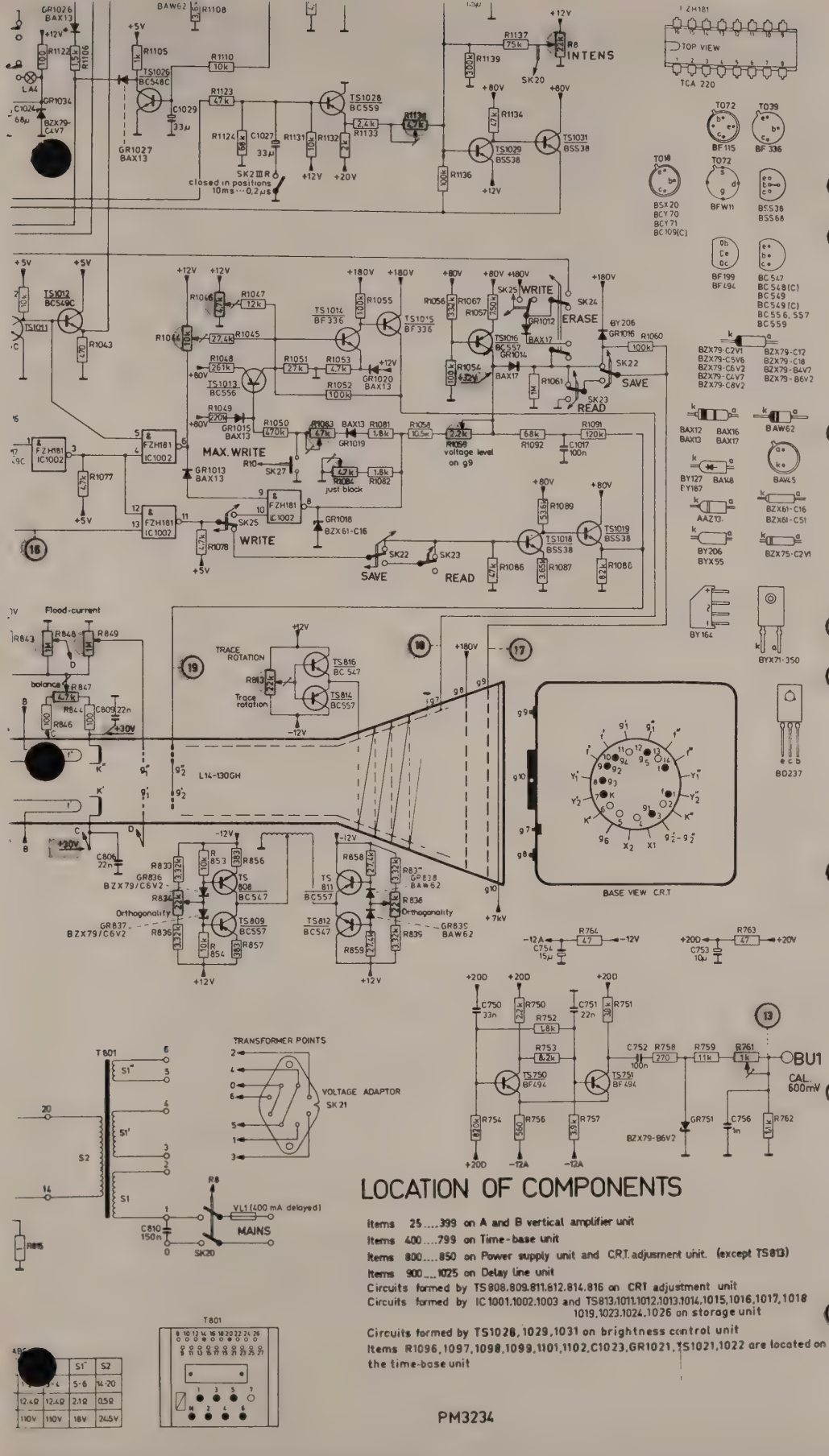
17c — Y=10 V/cm X=0.2 ms/cm
R10 (Persistence) counter clockwise
Storage mesh potential (≈2 kHz)

18 — ΔV collim R1044, Collim voltage level R1046
Y=20 V/cm X=0.2 s/cm
Operation time of SK24 (ERASE)
Collimator voltage (g7)

19 — Y=10 V/cm X=0.2 ms/cm
SK23 (READ) SK25 (WRITE)


AMPL. SWITCH YA (SK17)
TIME/div SWITCH (SK2)
AMPL. SWITCH YB (SK18)
DC BAL.
MAINS
TRIGG.
YA YB EXT MAINS + − AUTO AC DC SINGLE
MECHANICALLY INTERACTING
LEVEL
BU2 TRIGG.
BU3
BU4
BU5
SK18 I CLOSED IN POS.
SK19 CLOSED IN POS.


TIME/div
X-POSITION
5-times X MAGN.
SK2 IF
SK2 IIF
SK2 IIIF
SK2 IIR
SK3 CAL.
SK1
SK11
SK12
DC
AC
HOLD-OFF CAPACITORS
T.B. CAPACI-TORS
TB RESISTORS
CLOSED IN pos 1-10
CLOSED IN POS. 2-21
CLOSED IN POS.1
BU 6
T.B. OUT
Y'2 (C.R.T.)
Y1 (C.R.T.)
Y2 (C.R.T.)
Y_B POSITION
SK15 CLOSED FOR YB DISPLAY
DELAY LINE
6.3V D.C.
LA1
GR501 AAZ13
GR502 BAX13
GR503 BAX13
GR504 BAX13
GR901 BZX79-B4V7
GR902 BZX79/B4V7
GR1002 BZX79/B4V7
GR703 BAX13
TS501 BC549C
TS502 BF494
TS503 BC549C
TS504 BC549C
TS505 BC557
TS506 BC557
TS509 BSX20
TS511 BC559
TS512 BC549
TS513 BC549
TS516 BC547
TS602 BF494
TS603 BF494
TS604 BF494
TS606 BC547
TS704 BF115
TS706 BF115
TS1001 BC549C
TS1002 BF494
TS1003 BF494
TS1004 BC549
TS1005 BC548C
TS1006 BC549C
TS257 BF199
TS258 BF199
TS259 BF199
TS266 BC549
TS267 BC549
TS268 BF199
TS269 BF199
TS273 BF199
TS274 BF199
TS276 BF199
TS905 BC548C
TS906 BC549C
TS907 BF494
TS904 BC549
TS66 BC549
TS67 BC549
TS68 BF199
TS69 BF199
TS73 BF199
TS74 BF199
TS76 BF199
TS75 BC559
L803
L804
L805
L800



LOCATION OF COMPONENTS

Items 25....399 on A and B vertical amplifier unit
Items 400....799 on Time-base unit
Items 800....850 on Power supply unit and CRT adjusment unit. (except TS813)
Items 900....1025 on Delay line unit
Circuits formed by TS808,809,811,812,814,816 on CRT adjustment unit
Circuits formed by IC1001,1002,1003 and TS813,1011,1012,1013,1014,1015,1016,1017,1018 1019,1023,1024,1026 on storage unit

Circuits formed by TS1026, 1029, 1031 on brightness control unit
Items R1096, 1097, 1098, 1099, 1101, 1102, C1023, GR1021, TS1021, 1022 are located on the time-base unit

PM3234

Fig. 3.51 Circuit diagram

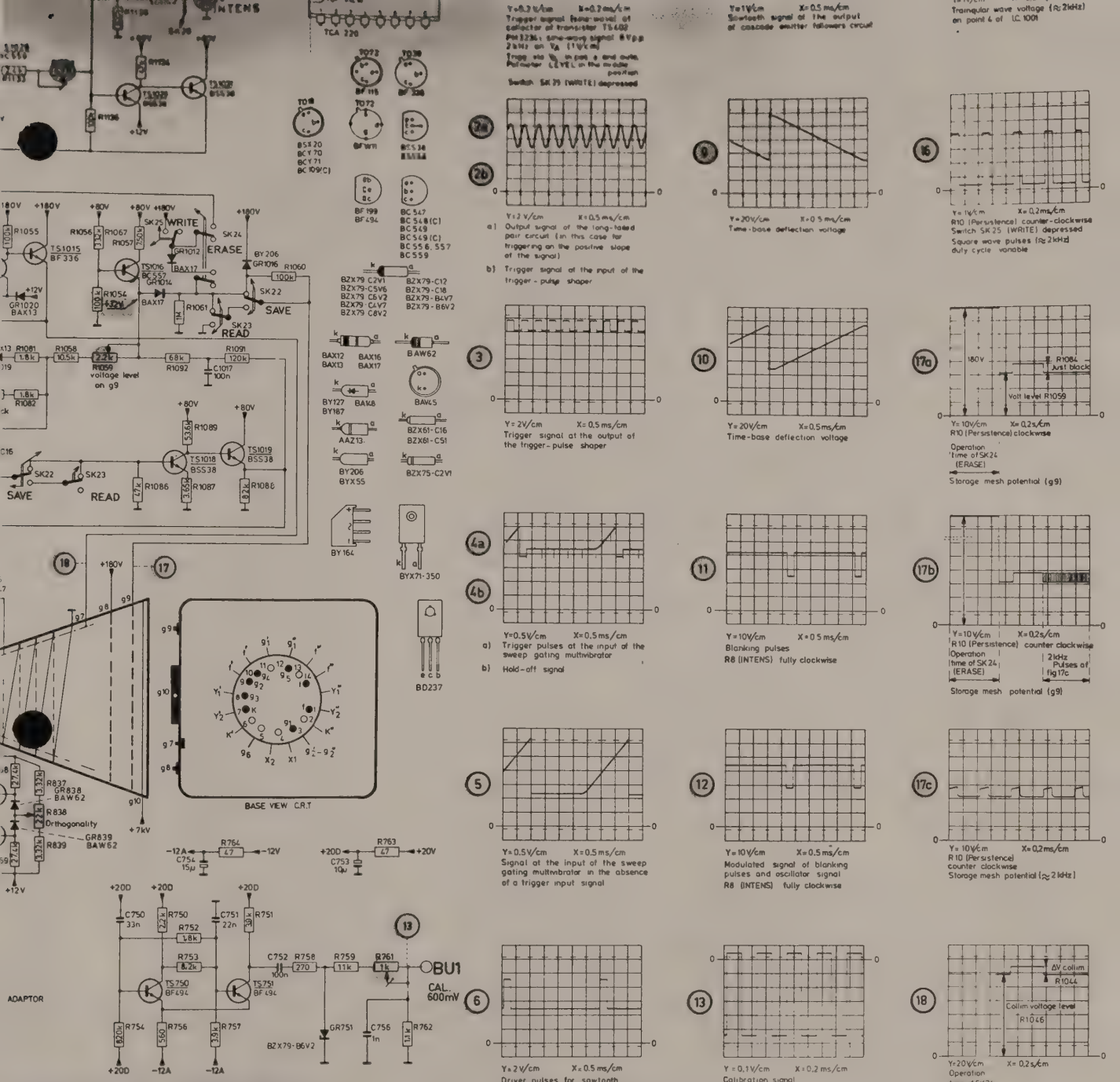


Fig. 3.51. Circuit diagram of the complete oscilloscope PM 3234

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS
(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐1 2 = 1,2 working hours (1 h 12 min.)

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